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IMPLICATIONS OF ATOMIC ENERGY

THE extent to which the problem of atomic energy and its utilization and control has taken hold of the public mind is well illustrated by the way in which the subject forced its way into Sir John Anderson's address on "Science and Reconstruction" in Manchester on December 6 and into the British Association Conference on "Scientific Research and Industrial Planning" in London on the following days. Both in Sir John Anderson's address and in that by Prof. C. D. Ellis at the British Association Conference, the question of the industrial use of atomic energy was put in its right perspective, and extravagant ideas as to its imminent use as a source of industrial power were dispelled. Both speakers indicated that the new range of radioactive substances which have become available may be vastly more important and bring a revolution into medical science ; and it was clearly recognized that, at any rate for the time being, the Government must take a leading part in the organisation of researches into atomic energy.

These, however, are not the considerations that are most widely prevalent in the minds of scientific men and their fellow citizens at the present time. Uppermost in the minds of men, as the hearings on atomic energy before the United States Senate and repeated debates in Parliament in Great Britain sufficiently testify, are the political consequences and implications. To some of these considerations Prof. E. L. Woodward devoted a recent lecture given at the University of Oxford. They have been further considered in an article, "The United Nations and the Atomic Bomb", in the December issue of the *Round Table*, and were referred to both by Sir Henry Dale and the Prime Minister at the anniversary dinner of the Royal Society held last November.

That concern has already led a number of distinguished scientific men and others in Britain, France, Belgium and Norway not merely to endorse the declarations of Mr. Eden and Mr. Bevin that there must be some abatement of national sovereignty, but also to propose in addition the establishment of an international police force as part of the security arrangements under the Charter of the United Nations, and a system of inspection linked with arrangements to secure free access for an international committee of physicists, chemists and engineers to all laboratories, industries and military installations, and the disclosure by each country of any new important scientific discovery. This suggested Committee, to be set up within the framework of the United Nations Organisation, would advise the military staff of the Security Council, so that the international police force would be at all times stronger than any group of potential aggressors. It would also have the duty of ensuring that peace-time industrial products should be difficult to convert to purposes of war and would advise what restrictions or safeguards it might be necessary to impose on the application of science to industry. The signatories of the statement summarized above, who

include Sir Arthur Salter, Prof. M. L. Oliphant, Lord Brabazon and Mr. A. Chester Beatty, also suggest that as part of a long-term programme, an international development body, attached to the United Nations, should be formed to co-ordinate and promote research and production in relation to the exploitation of the peace-time uses of atomic energy. Such research, they hold, must be carried out under international control.

Such positive proposals are in striking contrast to the pessimism that pervades Prof. E. L. Woodward's lecture. Prof. Woodward, it is true, is concerned purely with the political aspects, but valuable as may be his analysis and exposure of the unreality of some solutions of the problem currently offered, he offers no constructive proposals. He shows clearly that the choice before us is a choice between good and evil; but while he indicates that we still have time to think, he misses the implication that the problem is not simply a moral problem. It is a challenge to thought, and will be solved by courageous and creative thinking and by that alone.

Prof. Woodward's warning that there is danger of our being plunged into anarchy from which recovery could not be organised is timely, but is present already with every thinking man or woman, whether we regard the risk as greatest from deliberate choice of evil or from want of thought or judgment. But while he rejects in succession as impracticable four suggested answers to the question as to the organisation of security against the atomic bomb—that control is impossible, control by a single Power, control by a world government, and control by a special international organisation—the only positive suggestion he advances is that the United Nations Organisation should be reinforced by a simple pact whereby if any Power used the bomb without the previous unanimous approval of the Security Council, every member of the Organisation would immediately retaliate. Since it is difficult to believe that consent to the use of the bomb might never be unreasonably withheld, this proposal is tantamount to a self-denying ordinance on the part of conscientious Powers. Equally, the proposal implies that all nations will hold stocks of the atomic bomb. To this Prof. H. C. Urey has objected that if atomic bombs are made in one country, they will be made in all industrial countries; and he maintains therefore that no atomic bombs must be made anywhere, and they must not be in the possession of any government of any kind. It also runs counter to the idea implicit in the statement issued on the Moscow conversations, that the use of the atomic bomb and like weapons of warfare should be renounced by all nations.

Prof. Woodward emphasizes the impracticability of a *laisser-faire* policy, and the improbability that control by a single Power would ever be accepted, as well as the unlikelihood of a world government being established within the next ten years. His analysis of the difficulties that would confront any attempt at control by a special international organisation is lucid and valuable, as indicating what would be involved in a system of inspection and its administration; but it suffers from two defects. It is divorced from the technical aspects which must be decisive as to the practicability of inspection, for example, and in regard to administration it misses the compelling necessity that has been responsible for the attention which scientific men are now giving to the whole question.

Indeed, Prof. Woodward shows no awareness that we are, as Prof. H. Dingle has pointed out, at the opening of a new epoch, or he would have stressed more emphatically the most constructive suggestion he makes—that we should attempt to find out a little more about one of the main social activities of man by seeing whether properly directed research into the causes of war leads to valuable results. Until such inquiry has been made, we are, as he observes, in the dark about the value of any political arrangements which we may make for security. Furthermore, we cannot, as he implies, leave for later consideration the implications of atomic energy in other fields. Arrangements for controlling the production of the atomic bomb may indeed be upset by the application of atomic energy to peaceful purposes; but while we may leave for later consideration the problems of social, economic and political adjustment which will thereby arise, we cannot defer the consideration of the technical aspects of such developments if our plans for controlling the production of atomic energy for any purpose are to be technically valid. If mankind is to enjoy the advantages of atomic energy, it must face from the start the implications of the problem as a whole.

That is the consideration that has clearly been uppermost in the minds of the American men of science who have given evidence at the hearings on atomic energy before the United States Senate, and notably in the statements from Dr. J. R. Oppenheimer; and it was emphasized in Sir Henry Dale's speech at the anniversary dinner of the Royal Society. These implications have political as well as scientific aspects, and the two aspects are not always easy to separate. For example, the magnitude of the scientific and technical effort which has been devoted to the development of the atomic bomb during the War is not even yet fully appreciated. Without ignoring the value and significance for peace-time purposes of the striking team-work in science which has gone to that development, it is well to remember that that effort has inevitably retarded the exploration and development of other fields. Even world scientific resources are not unlimited, and Prof. M. Polanyi, like Dr. Oppenheimer, has uttered a wise warning as to the danger to fundamental research as a whole if we continue to devote resources to the development of atomic energy on the scale of the past five years.

That, however, was not the danger to science with which Sir Henry Dale was chiefly concerned. Emphasizing the right and the duty of men of science to speak on the use and dangers of the new discoveries on atomic energy, he discussed more particularly the effect of present and prospective developments upon the integrity of science itself and the serious danger of the intrusion of an element of secrecy. Prof. Woodward directs attention to the bearing of the

atomic bomb on political liberty, as we understand it, of which the freedom of science is a part; and while there may be some general reassurance on that point in what the Prime Minister said, Mr. Attlee said too that he believed that the free interchange of knowledge can only be realized in a world from which war has been banished. Here it is pertinent to recall Sir Henry Dale's remark that in default of international agreement, national military secrecy might try to maintain or to extend its war-time dominance, and it is difficult to forecast the extent to which the domain of science might thus become involved. Already, as he indicated, the return of leading men of science to the universities and their own laboratories and the pursuit of fundamental research lags behind the pace at which ordinary scientific work was resumed after the First World War, and if, on top of this, military secrecy successively encroaches on the freedom of science, a dangerous wound will undoubtedly be inflicted on the free spirit of science. There appears to be no division of opinion on this issue among scientific workers anywhere in the world, and there is evidence that there will be no lack of response to Sir Henry Dale's finely worded appeal to stand together against the threatening danger, determined to preserve the integrity of science, to prevent its further perversion from its proper and beneficent uses, and to save mankind from misusing science for its own destruction.

Men of science, as Sir Henry Dale indicated, are not disposed to accept, as a result of victory in a war for the freedom of civilization, a tightening of restrictions accepted as necessary to the gaining of victory. They have a right to expect, he declared, that freedom thus surrendered will be restored, and in particular freedom from secrecy and freedom from national barriers. Indeed, what the politician has yet to recognize is that without such freedom there can be no security. The fetters imposed on science in the name of security can never altogether fulfil that purpose: ultimately they tend to insecurity, by the frustration of science and the distrust that secrecy always breeds in a community of nations no less than of individual men and women.

While, therefore, Mr. Attlee may hold that the ideal of full freedom in the interchange of knowledge can only be realized in a world from which war has been banished, what needs to be added is that such a condition must be achieved as a matter of desperate urgency if the work of science is to continue, and if civilization is not to be overwhelmed by barbarism. That note of urgency and insistence on the vital importance of free and full exchange of men of science and information is exactly what is most lacking in the Moscow statement in comparison with the Three Power declaration. Scientific workers will not fail to observe that the former statement omits the following sentence: "Specifically it is considered that the Commission might well devote its attention first to the wide exchange of scientists and scientific information, and as a second stage to the development of full knowledge concerning natural resources of raw materials". Moreover, the omission of the whole of the ninth point of the Three Power Declaration is in striking contrast with the concluding paragraph of Section VII of the Declaration which apparently replaces it. This weakening of the original proposals might be viewed with less concern were there more evidence that the U.S.S.R. are prepared to shoulder the responsibilities implicit in the United Nations Organisation. All nations must realize that the welfare of mankind, the advancement of science and the development of material resources which it has put at our command alike demand a world of peace, where free peoples freely co-operate for their common ends.

Already the idea that some limitation of national sovereignty must be accepted if solution is to be found to the problems raised by the atomic bomb has been recognized by British statesmen of all political parties. There can be no disguising the difficulties that have still to be overcome in working out any satisfactory solution; and they are not concealed in the Three Power Declaration on atomic energy. Prof. Woodward's lecture is at least a stimulus to the realistic thinking required. But what above all is essential is the note of urgency and the creative, as well as realistic, thinking that an entirely unprecedented situation demands. We may well apply to the international situation words which Col. Urwick used of the human situation in industry at the recent conference arranged by the British Association (see *Nature*, Jan. 5, p. 8): it is a problem in thinking that confronts us, and if the dangers inherent in the new knowledge of atomic energy and its application are to be averted and we are to come in the post-war years to a fresh flowering of science and of culture, it will only be as something of the same creative thought is brought to bear on political organizations and human relations within and across national frontiers that has given us so many of the striking advances in science of the last thirty years.

That may well have been in Prof. M. Polanyi's mind when, in his address on "The Social Message of Pure Science" at the British Association conference referred to above, he pointed out that men of science are pledged to values more precious than national welfare, and that they could give the world to-day an example of the good life; and he claimed that, given freedom to travel as they pleased through Europe, they would restore within six months close and intensive collaboration of all scientific workers in Europe. Moreover, while, like Mr. Attlee, Prof. Polanyi recognizes that human activities cannot be separated into compartments, and that the revival of international scientific life is only part of the restoration of reason and civilized human intercourse in Europe, like Sir Henry Dale he insisted that something more than meetings of national representatives and delegates is required. He pleaded not for formal mechanism, but for that informal intercourse which will come by the mere extending by the United Nations of the privileges of diplomatic passage—or at least the privileges of the Press—to scientific men and other scholars all over the world.

This vision of the man of science playing the part of the wandering scholar of the Middle Ages, when

learning had claims to be considered a third power on a level with the imperial authority and the ecclesiastical hierarchy, is not altogether fanciful. Scientists of different countries, meeting simply as scientists, for the frank and informal interchange and friendly criticism of each others' observations and ideas, in complete freedom from any national inhibitions or restrictions, would indeed, as Dr. Oppenheimer also suggested in his evidence before the U.S. Senate, make an important contribution to the weaving together of the broken fabric of Western civilization as well as to the advance of science. A powerful stimulus would be given to that community of ideas and thought which must form the basis of an international order and the surrender of national sovereignty. Further, since the final reason for the surrender of a degree of national sovereignty and the evolution of a new form of world organisation is the new powers which science has put into the hands of men, it is fitting that men of science should lead the way towards re-establishing the contacts and the intercourse of minds out of which alone can come the creative thought needed to shape the new institutions.

On that ground in particular, scientific workers should welcome the wider opportunities which may now come to them through the United Nations Educational, Scientific and Cultural Organisation. As the constitution adopted on November 16 declares: "since wars begin in the minds of men, it is in the minds of men that the defences of peace must be constructed"; and accordingly the members of the Organisation are pledged themselves to develop and to increase the means of communication between their peoples, and to employ these means for the purposes of mutual understanding and fuller knowledge of each others' lives, believing in the unrestricted pursuit of objective truth and in the free exchange of ideas and knowledge. The Organisation is pledged specifically to promote the free flow of ideas and to encourage international co-operation in all branches of intellectual activity, including alike the interchange of scientific and cultural personnel and the exchange of publications. Even the immediate practical task of dealing with educational, scientific and cultural reconstruction in the countries devastated by the War, which is to be examined by the Preparatory Commission, can scarcely fail to provide some stimulus to the process visualized by Sir Henry Dale and Prof. Polanyi.

The appeal which the late Dr. E. F. Armstrong made in his last article in *Nature* (Dec. 25, p. 708), to accept the responsibility for recreating the moral life of the world which the new Organisation offers to scientific workers, is strongly reinforced by the many difficulties which the release of atomic energy has brought in its train. Scientific workers must carry the main responsibility for arousing their fellow-citizens to a sense of urgency and for dispelling the technical ignorance and the lack of imagination which have prevented most people in all countries from appreciating the significance of what has happened in the last few months. They of all men are best placed to interpret to the world the new and imperative meaning to the harmony of interests among the nations which the development of atomic energy has given. To some extent, too, the world may look to them for a contribution to the creative thinking out of which will come the new forms of organisation and the machinery of control designed to avert disaster and enable mankind to enjoy the benefits of this and other developments which the future must bring.

If, however, that contribution is to be effective, it must be made, not in isolation, but in fellowship with men of learning and goodwill everywhere; scientific workers must address themselves to constructive thought, to the application of the outlook and method of science into this whole field of politics and the machinery of government, and to that equally important task of educating those who are not men of science regarding the nature and the value of the help which the scientific attitude of mind can give them.

On the speed with which the United Nations Educational, Scientific and Cultural Organisation succeeds in setting forth clearly and concisely the problems first to be attacked may well depend the ability of the United Nations to create effective instruments for world co-operation and order, and to weave again that fabric of common understanding, culture and interest, to which freedom of communication makes so large a contribution, and without which no machinery or instrument for international co-operation can function. That there should be such ample evidence that scientific men in Great Britain and in the United States are thinking constructively on similar lines, and that responsible statesmen are admitting the imperative necessity of accepting limitations on national sovereignty are sound reasons for cautious optimism. Although we may still need to proceed by stages and progress is unlikely to be rapid—though some first steps must be taken speedily—we can regard the future more hopefully than is suggested in Prof. Woodward's somewhat pessimistic address.

PRINCE OF BIBLIOGRAPHERS: EMMANUEL DE MARGERIE

Critique et géologie

Contribution à l'histoire des sciences de la terre (1882–1942). Par Emm. de Margerie. Tome 1. Pp. xx+659. (Paris: Armand Colin, 1943.)

ONE recalls how Émil Argand exclaimed "Prince of Bibliographers!", when he returned thanks to Emmanuel de Margerie for assistance rendered in the production of his "Tectonique de l'Asie", presented at the Brussels session of the International Geological Congress, 1922. Now, after sixty years of fruitful service generously given to geologists and geographers of all lands, this 'Prince' has planned a monument in which, to adapt his own words, he is to sketch his whole intellectual life for the sake of those who have interested themselves in his works or who propose to continue them. The monument is to take the form of four volumes, of which the first has appeared; the second and third are in proof and the fourth is well in hand. The project has been made financially

possible through the award of a generous prize, 50,000 lire, by the Pontifica Accademia delle Scienze in 1943. This was an international act of peace in war reminiscent to some extent of the award of the Bonaparte Medal and Prize to Humphry Davy. Paper shortage has restricted the issue of the first volume to 500 copies, examples of which have been given in Britain to the Royal, the Royal Geographical and the Geological Societies. It is important, therefore, to indicate what readers will find in its pages. To begin with, let us say that the subjects treated concern physical aspects of geology and geography.

Volume 1 starts with chronological lists of de Margerie's main publications and reviews, the latter grouped according to the twelve journals to which they were contributed. All told, these lists occupy ninety-five pages.

Then follows an "Introduction", pp. 96–136, furnishing a brief family and personal history. Born in Paris, 1862, de Margerie made his first geological excursion in 1874, when he joined a party organized by the Muséum de l'Histoire Naturelle visiting sections in the neighbourhood of Paris. Next year, by accident, he encountered at Chamonix a delegation of the Geological Society of France assembled to inaugurate a monument to Jacques Balmat, guide of the celebrated de Saussure. From that moment, he tells us, he conceived a keen desire to join the learned company. This wish was consummated in 1877 on de Lapparent's proposal. The following year, the first meeting of the International Geological Congress was staged in Paris along with the 'Exposition Universelle', and brought to de Margerie a great extension of horizons. He found himself, for example, introduced to Heim's work in the Alps, to the United States atlas of Colorado and to Favre's experiments on mountain building. Actual publication started in 1882, when de Lapparent confided to de Margerie, now in his twentieth year, the preparation of an abstract of a memoir on New South Wales, which had been presented in English at the second meeting of the International Geological Congress, held in Bologna, 1881. Space forbids us to follow the further progress of de Margerie's activities, except in so far as they concern the main part of volume 1, entitled "Première Partie, Études Générales", pp. 137–659.

The matter of this first part is grouped about four major works in which de Margerie played a leading part. Let us take them in order of treatment.

(1) "Les Dislocations de l'Écorce terrestre", dealt with in pp. 138–193 of the volume under review. In 1882, de Margerie called at Zurich and joined in a students' excursion under Heim, at which, incidentally, the Geological Society of Switzerland was founded. Next year, during a second call, de Margerie planned with Heim the bilingual, largely trilingual, French-German-English publication of which the French title is given above. The object was to bring method into the rapidly expanding science of tectonics and provide it with an authoritative language. Results of essentially vertical and essentially horizontal movement had to be distinguished; successive stages in homologous series had to be correlated; clear definitions had to be supported by clear illustrations; and, wherever possible, references had to be given to original sources. "Les Dislocations" eventually appeared in 1888, with the cost of publication partly met out of a fund endowed by the musical artist Schnyder von Wartensee. In the volume before us, a full indication of the contents of the book is coupled with specimen pages and many sample illustrations. Then follow reviews and notices, among which Judd's in *Nature* is outstanding, since the north-west Highlands had recently brought home to British geologists the existence of large-scale tectonics. An account is added of certain vaguely analogous 'dictionaries of geology'; after which, seven reviews from de Margerie's pen dealing with tectonic subjects are reproduced. In this section, as in others, de Margerie gives a number of facsimiles of original letters received from correspondents, and includes among his illustrations many portraits.

(2) "Les Formes du Terrain", pp. 194–347. In 1879 de Margerie joined the Club Alpin Français, and this indirectly led to his introduction in 1883 to Commandant de La Noë, later brigadier-general and director of the Service Géographique de l'Armée. Despite twenty-six years disparity of age, the two soon reached complete understanding. De La Noë supplied a profound first-hand knowledge of earth forms, de Margerie an exceptional acquaintance with apposite geological literature, especially that emanating from the United States of America. In 1888 "Les Formes du Terrain" was published by the Service Géographique de l'Armée above their joint signatures. The work claims pre-eminence for the erosive achievements of river and rain guided by geological structure. Classification on the basis of cause and effect, clear exposition in word and diagram, and copious references to selected examples both in the field and in the literature are to be found throughout. The remainder of this section furnishes reviews and notices, which can be grouped under the general heading of "Formes du Terrain". Perhaps the most interesting are by de Margerie himself, including an appreciation of W. M. Davis's ideas of cycle of erosion and of young, mature and senile topography (pp. 268–271), and of General Berthaut's influence upon topographical representation through his insistence upon the significance of topology (pp. 286–325, in part previously unpublished). Berthaut was largely concerned with North Africa, where the skeleton of scenery is often starkly exposed.

(3) "Le Catalogue des Bibliographies Géologiques", pp. 349–373. De Margerie was first inspired to propose a catalogue of geological bibliographies when in 1885 he became acquainted with a geographical list of similar scope, published by James Jackson in 1881. At the Washington meeting of the International Geological Congress, 1891, he won approval for his project, and was appointed secretary. A start was made on board a train that carried an excursion to the Rockies. There were many contributors, but the work devolving on the secretary was prodigious. The catalogue appeared in 1896 and the costs were met by the Washington (1891) and Zurich (1894) organization committees of the Congress. De Margerie's volume 1 sets out in its own style the nature of the "Catalogue" and of its welcome, as well as many facts concerning subsequent developments. For these latter, which are very important, the reader may perhaps prefer to turn to a critical digest which A. Renier has already furnished to the Société Géologique de Belgique (1944).

(4) "L'Édition française de 'La Face de la Terre'", pp. 374–659. All geologists are aware of the immense international importance of Suess' "Antlitz der Erde", wielding an influence on their science comparable with that of Lyell's "Principles" or Darwin's "Origin of Species". Suess aimed at collecting and

co-ordinating all that was known of the physical history of the crust of the earth, its physiognomy and its anatomy. The first part of the first volume of the "Antlitz" appeared in 1883 and was picked up almost immediately by de Margerie in a shop in Zurich. This first volume was completed in December 1884, and by April 1885 de Margerie had published a review. The second volume of the "Antlitz" appeared in 1888, and the same year de Margerie concluded a short notice with the words: "Nous appelons de tous nos voeux une traduction française pour cette œuvre capitale".

The idea received strong support, but negotiations dragged on. The first publisher approached decided after inquiry that he would not be able to dispose of more than three hundred copies. Fortunately, Armand Colin was more optimistic. Publication was agreed in 1893, and the three volumes of the completed translation appeared between 1897 and 1918. The demand has already reached 18,000 copies!

Let us quote from a review in *Nature* by Sollas (1919): "It is much more than a translation; by the addition of numerous footnotes and illustrations it becomes a new edition. . . . Suess introduced only 168 figures into the text. The French have given us more than thrice the number (in all 552 figures). . . . The added notes . . . are of great value; they bring the bibliographical references up to date, and when necessary point out how far the author's conclusions must be modified in the light of later knowledge." Sollas adds that the English edition "contains no new matter". This is very generous, for the English edition was published, during 1904–9, under his own direction, and has proved of very great value to English-speaking readers. At the same time, "La Face de la Terre" is a unique production to which the present reviewer, among others, attributes his allegiance to the science of geology. In its preparation de Margerie had collaborators, but his own share was pre-eminent. E. B. Bailey.

REBUILDING FAMILY LIFE

Rebuilding Family Life in the Post-War World

An Enquiry with Recommendations. Edited by Sir James Marchant. By Lord Horder, R. M. Titmuss, W. B. Reddaway, Sir John Boyd Orr, Prof. F. A. E. Crew, Sir Arthur MacNalty, Dr. Margaret Jackson, Dr. Eliot Slater, Dr. Grace Leybourne-White and the Rt. Rev. Dr. E. J. Hagan. Pp. 138. (London: Odhams Press, Ltd., 1945.) 2*s*.

ONE of the most interesting features of contemporary thought is the virtual unanimity with which importance is attached to family life and the careful consideration which is being given to its sustenance and rehabilitation. In such consideration this small volume will be most valuable. Rarely, indeed, can so few pages have contained so much solid food for thought and so many valuable suggestions for action.

After a characteristically wise introduction by Lord Horder on the theme that "Mankind is a Collection of Families", Richard Titmuss gives a lucid account of the statistics of parenthood, making it clear that the higher birth-rate of the last few years has been achieved only by 'recouping' from the past and 'stealing' from the future. While handling his demographic indices with dexterity, however, Titmuss remembers that "people do not behave as averages" and stresses the importance of bringing about a state of affairs in which many more parents will actively desire large families.

How this desire may be fostered by economic and social measures is the problem discussed by W. B. Reddaway. After pointing out that bringing up children costs both money and labour, he urges a co-ordinated effort to reduce the burdens of parenthood. Most of his proposals (such as family allowances payable by the Treasury and improved social attitude towards families) are sure to receive wide support and would help considerably in achieving the desired objective of "making parenthood reasonably attractive".

If family life is the basis of society, food is clearly the basis of family life. It is so, not merely because it provides calories and vitamins but also because "A meal should be the means of a happy reunion of a family in a spirit of harmony". After retelling the dismal story of dietary decline in nineteenth-century Britain, Sir John Boyd Orr comments that "What we should aim at is not so much the building of hospitals to cure disease as the building of children who will not need to go to hospital".

After these socially significant papers, Prof. F. A. E. Crew's somewhat academic outline of the biological aspect of sex inevitably seems something of an intrusion. The main thread, however, is taken up again by Sir Arthur MacNalty, who considers the evil effects of disease on family life, stresses the importance of an extension of maternity and child-welfare work and urges the study of social medicine.

Dr. Margaret Jackson considers the possible causes of the dwindling family and presents the usual factors of economic competition, domestic drudgery, housing difficulties, mass unemployment, etc. Also, however, she detects the underlying spiritual *malaise* of a society with no real faith in its future. In the next paper, Dr. Eliot Slater points out that a Gallup Poll has shown that "Although married people want fewer children nowadays than they used to, they do not want so very few that the race would be in any danger—if they had as many as they wanted", and draws the conclusion that "All that is needed . . . is the right social circumstances for the expressing of this desire". Dr. Slater also makes the interesting suggestion that the million or so British women for whom there are no husbands might be given the opportunity of motherhood, perhaps by artificial insemination.

Dr. Grace Leybourne-White insists upon the necessity for "a real transformation in our State primary schools", "a parity of esteem between the various parts of a State secondary system", "a real democratization of the public schools", and "a completely equal opportunity for all" in the universities and the professions. Only thus, she claims, will the dysgenic effects of high educational costs be overcome. The Right Rev. E. J. Hagan then considers the spiritual aspects of family life, and with most of his thesis there will be general agreement. When, however, he affirms that "to achieve the highest happiness in marriage calls for the exercise of the Christian Faith" one is bound to ask, may not others (Jews, for example) hope for such achievement?

The final paper, by Sir Arthur MacNalty, on the "Influence of War on Family Life", retails the now familiar tale of destruction of lives and homes, disruption of families, weakening of parental control, and so on. It poses the great problem: What are we going to do about it? Cyril Bibby.

THE BRITISH COMMONWEALTH SCIENTIFIC OFFICE IN WASHINGTON

By Dr. ALEXANDER KING

DESPITE many attempts to prove the contrary, the sciences have remained genuinely international in content and development, while their application in all the diverse fields of human endeavour has assumed recognizably similar forms even in the most varied geographical and political environments. An interesting example is the development of weapons and of instruments of war, which has been along broadly similar lines in all those countries possessing sufficient technical resources to enable serious progress to be made. In nearly all directions in which the Allies achieved notable success, Germany had also experimented—and vice versa. This is, of course, because such developments are based on identical scientific principles, already well known internationally before the War.

It was to be expected that the Allies would reach agreement early in the War to exchange information on those categories of technical development which had in the past been restricted from publication, and furthermore agree to collaborate in active programmes of war science. This was an obviously necessary measure if a safe distance were to be maintained ahead of a resourceful enemy, fully mobilized for technical warfare. Co-operation in scientific research between the countries of the British Commonwealth and the United States has in fact been remarkably intimate and harmonious throughout the War; it has proved a potent factor in our ultimate technical victory over the Axis. Much has already been made public of the achievements of the joint Anglo-American effort in particular technical developments, but little has yet been told of the means taken to ensure day-to-day contact between the scientific workers of America and those of the British countries.

Following the success of Sir Henry Tizard's technical mission to the United States in the autumn of 1940, it was decided to establish in London a mission of the American Office of Scientific Research and Development (O.S.R.D.) and in Washington a British Central Scientific Office (B.C.S.O.). Both these missions have continued to work successfully throughout the War, passing across the Atlantic an enormous quantity of scientific and technical information, the bountiful harvest of the research efforts of the two great countries.

Sir Charles Darwin sailed in the early spring of 1941 to take up his position as first director of the British Central Scientific Office, of which Dr. W. L. Webster was secretary. A number of immediate problems awaited them, particularly in connexion with American radar and fire-control developments, but a major part of the time of this first group of scientific men was taken up with making general surveys of technical work important for the War and then just commencing in the arsenals, industrial laboratories and universities of the United States. It was important at this stage that contact should be made between individual workers on general problems on both sides of the Atlantic, and as an immediate result of the preliminary labours of the two scientific missions, a very large number of American specialists visited England to obtain first-hand information of the work of their British colleagues, while British men of science flew to the United States for quick consultation with their American opposite numbers. From its inception, therefore, the British Central Scientific Office in Washington had an important function in making arrangements for short visits of British men of science to the United States and ensuring their easy entry to the American laboratories. This service still continues to-day.

As the War progressed and the technical requirements of the three Services became more complicated, it was necessary to attach scientific workers to the Service missions in Washington, but the British Central Scientific Office remained as an inter-Service and inter-departmental centre, the liaison officers of which had to cover an ever-increasing field of scientific research and technical development. The scientific men in the British Central Scientific Office also formed a body of consultants readily available to the missions in Washington of these Service and supply departments.

It is not yet possible to mention many of the topics with which the Office has been concerned, but they range from light alloys for aeroplane construction, through gun erosion, the development of rockets and other special weapons, chemical defence and explosives to medical and agricultural research problems, as well as the protection of Service equipment from the ravages of Nature in the tropics.

The services provided by the Office have extended beyond the transmission of formal research reports and the specific replies of its scientific men in response to questions asked by the Ministries in London. They have included the purchase of scientific stores and materials of all kinds for urgent research purposes in Britain, the maintenance in Washington of a comprehensive library of British and American technical information for the use of British missions and American Government agencies, the sponsoring of British and Dominion scientific workers on short-term visits to enable them to enter American establishments where secret work was in progress, and many other matters which, notwithstanding their routine nature, have been extremely important in the aggregate. The organisation of an office of this type is in itself an interesting evolution, since, owing to the vital urgency of its work, extreme efficiency of operation is demanded, while at the same time the diverse and specialized nature of the scientific inquiries which have to be made necessitates a high degree of flexibility and gives to the scientific officers great individual responsibility and independence of action. Throughout the War, most of these men have been academic men of science on loan from the universities. They have done a magnificent and strenuous job, obtaining information which at times required high scientific attainments and common sense for assessment; they succeeded in establishing close personal relations with their American colleagues who, in the case of the Office of Scientific Research and Development contacts in particular, were mainly university men also.

From the time of the Tizard mission, very close relations had been maintained between the National Research Council of Canada and British scientific workers in the United States. Later, too, Australian and New Zealand Scientific Missions were posted to the Washington Legations of these countries, and the Dominion men of science collaborated closely with their colleagues from the United Kingdom. During the time when Mr. T. W. J. Taylor was director of

the British Central Scientific Office, it became apparent that relations between the scientific men of the various British countries in Washington might with advantage be still closer, so that in the autumn of 1943, the scientific missions of the United Kingdom, Australia and New Zealand moved into common premises adjacent to the liaison office of the United States Office of Scientific Research and Development.

Shortly afterwards, the National Research Council of Canada sent liaison representatives to the British Central Scientific Office, while a number of scientific workers from South Africa joined the British group, and negotiations were begun between the present writer, who had then succeeded Mr. Taylor, and the heads of the Dominion scientific offices, to pool their resources still further. With the consent of the American authorities, the various national sections of the office federated in July 1944 to form the present British Commonwealth Scientific office. This change of name allowed the designation "B.C.S.O.", which was by that time well known throughout American scientific and government circles, to be retained for the office as a whole, while the mission from Great Britain, still numerically the strongest unit, was renamed the United Kingdom Scientific Mission.

The British Commonwealth Scientific Office in Washington has for its pattern the structure of the Commonwealth itself. Each constituent national unit is completely autonomous and at liberty to take independent action on any subject; in practice, the groups run in the closest collaboration, which is made all the more smooth because so completely lacking in compulsion. The director of the British Central Scientific Office became, under the new scheme, head of the United Kingdom Scientific Mission and director of the services provided in common to the United Kingdom and all the Dominions. These include the provision of clerical staff, arrangements for photography and the copying of reports, purchase of books, specifications and periodicals, travel and hotel reservations and the obtaining of clearances to visit laboratories in the United States.

The advantages of the present system of working are numerous; the disadvantages simply do not exist. It is a matter of convenience to the American authorities to have a single approach for a particular piece of information on behalf of the whole group, rather than five separate applications. Moreover, the increased number of scientific workers which is made available by the amalgamation of the separate missions enables a wider range of subjects to be covered in a more specialized manner.

As an example might be cited collaboration in the development of D.D.T. and insect control measures which have proved so successful in their Service use. The British Commonwealth Scientific Office liaison representatives on this subject consist of an entomologist from Australia and a physical chemist from Great Britain. These men have sat with the American committees on their own particular aspects of the problem, and have reported their results to all the countries represented in the British Commonwealth Scientific Office. In a similar manner, work on the prevention of equipment deterioration in the tropics has been covered by the working together of liaison officers from the United Kingdom and Australia, general medical matters by a South African medical man, food processing and nutrition by a scientific worker from New Zealand. The close proximity afforded by a common office enables hour-by-hour consultation to be made between the different national units of the British Commonwealth Scientific Office and, what is more important, between scientific workers interested in different aspects of a common problem.

The United Kingdom Scientific Mission is on the vote of the Ministry of Production, policy and staffing being decided by the Scientific Sub-Committee of the North American Supply Committee of the Cabinet. Being centrally placed in the government machine, therefore, the Office can serve all departments equally. The British Commonwealth Scientific Office is also able to represent British groups not possessing members in Washington. For example, much information is sent to India, and frequent inquiries for American technical information are made on behalf of the Colonies, particularly those of the Caribbean area.

The establishment and working of the British Commonwealth Scientific Office has proved that scientific men of the various British countries can work together in the common interest in complete harmony which transcends national differences. Such working together does not endanger the independence of action of any group or subjugate its local needs to the interests of the others. Relations established both within the Office itself and between the British men of science and their many American colleagues will remain long after all these men have returned to their normal peace-time duties, for in no other human activity is intellectual collaboration so natural or so enduring. This unique experiment in collaboration has been born of the necessity of war, but it is at least a pointer to future possibilities.

BIOLOGICAL STIMULATION IN GERMINATION

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Introduction

MANY seeds, spores, and pollen grains will only germinate when they are associated with active independent tissues. Moreover, many of the characteristics of the situation are strikingly similar in the different groups. Some of these similarities have already been emphasized by other writers, others have not. It is the purpose of this article to provide a general review of the subject based on the contention that many of the similarities are sufficiently close to warrant the hypothesis that the same phenomenon is involved throughout the several groups. The subject is one of some significance in two connexions. An examination of the nature of the stimulation contributes to an elucidation of one aspect of the germination process and is therefore relevant to a consideration of the factors involved in dormancy. Secondly, as indicated below, the effect is undoubtedly due to the production by the active tissue of particular chemical activators which promote the development of the dormant unit. It is probable that many of these have not hitherto been isolated and identified, and the topic has therefore important implications for the general subject of growth-promoting substances.

Below, in the interests of brevity and convenience, two terms are used with particular meanings;

'germ' is used as a collective term for seeds, spores, and pollen grains, and 'dependent germ' for those that require stimulation.

Incidence of the Phenomenon

In 1887, Koch[1] reported that the seeds of various species of *Orobanche* would only germinate when they were accompanied by the roots of a host plant. Heinricher[2] made a similar observation with regard to the seeds of *Lathræa* and *Tozzia*, and later other investigators found that the same condition is required for the germination of the seeds of *Aeginetia indica*[3], a parasite of sugar cane, of certain species of *Striga*, which attack the roots of a variety of crop plants, and of *Alectra vogelii*[4], which parasitizes a number of leguminous crops. Certain orchid seeds show a similar condition, although the stimulating organism in this case is a fungus. In 1903, Noel Bernard[5] presented evidence to show that the germination of some species of orchid seeds is considerably enhanced by stimulation from a fungus mycelium. The pioneer investigations of Bernard himself suggested that all species are not fungus-dependent to the same extent and later investigations and notably those of Burgeff[6] have also shown that the extent to which independent ('non-symbiotic') germination can be induced may depend on the nature of the medium on which the seeds are cultured. Knudson[7,8,9] has stressed this latter aspect of the matter, but Schaffstein[10] and Downie[11,12] have provided further evidence to show that in certain circumstances the fungus is indispensable to germination, which is probably in all circumstances more vigorous in the presence than it is in the absence of the fungus.

The pollen grains of many species will germinate either in the presence of water or of a solution of sugar, but some require the further provision of contact with stigmatic tissue. According to Brandscheid[13] the phenomenon was investigated by Strasburger, who found that stimulation could be induced with the stigma of a species other than that of the pollen grain. Burck[14] reported that the pollen of *Mussaenda* required stimulation from a stigma of the same species, and later workers have described several other instances of the same type. The most elaborate investigation of the condition has been made by Brandscheid[13].

With fungal spores, W. Brown[15] quotes a report by Neger that those of *Bulgaria polymorpha* react to stimulation by an independent tissue, and W. Brown himself showed that bruised fragments of certain plant tissues enhanced the germination of spores of *Botrytis cinerea*, *B. parasitica*, *Fusarium* sp., and *Penicillium glaucum*. Later work by other investigators has shown that host stimulation in the germination of the spores of parasitic fungi is a comparatively frequent phenomenon. The present review is concerned primarily with plant tissues, but in this connexion it is of some interest that a somewhat similar condition may be involved in the hatching of the larvæ of the cysts of *Heterodera schachtii*, since it has been shown that these react to stimulation from the host root[16].

Nature of the Stimulation

Throughout the several groups, the basis of the stimulation is undoubtedly the same: it involves the production by the active tissue of a chemical substance which is necessary to the development of the germ. A simple contact stimulus is in all cases excluded, since immediate contact between the two bodies is apparently unnecessary; even indirect contact through a liquid medium is not in all cases essential. For example, in the experiments of W. Brown[15] fungus spores responded to the stimulus of a tissue which was separated from the drop in which they were immersed by an air gap. Similar results were recorded by Burgert[16] with the spores of *Phyllosticta solitaria* and by Noble with those of *Urocystis cepulæ*[19]. The interpretation suggested by W. Brown for the results of his experiments, that a volatile substance which stimulates the development of the spore is released from the bruised tissue, traverses the air gap, and is finally absorbed by the spore is probably applicable to other similar observations. In the majority of cases, however, the two organisms must be connected through some form of aqueous medium before germination can occur. The effect of stigmatic tissue on the germination of pollen grains has been demonstrated by placing stigma and pollen in the same drop of liquid; that of fungus mycelium on orchid seeds by culturing both on the same aqueous medium; and that of roots on parasite seeds by growing the former in soil containing the latter. In these cases in which a liquid bridge is essential, the effect may be due to the absorption by the germ of a substance which is formed in the active tissue; but two other possibilities must be considered: that the active member of the pair modifies the reaction of the medium making it more suitable for germination; and that it induces changes in the composition of the medium involving the release of substances which promote rapid germination.

With pollen grains the liquid medium may contain a nutrient but not invariably; and when it does not, the effect of the stigmatic tissue cannot be that of modifying any original nutrient mixture. Brandscheid[13] investigated the effect of acidity and found that, whatever the acidity, the stigmatic tissue always enhanced germination and therefore had an effect independently of the reaction of the medium. With regard to orchid seeds, Knudson[7,9] suggested that since in his experiments the effect of the fungus was most pronounced when the medium contained insoluble carbohydrates in the form of starch, the enhanced growth of the seedling was due to a rapid hydrolysis of the starch by enzymes released from the fungus; and also that the fungus adjusts the reaction of the medium to a state which promotes germination. Downie has shown, however, that with certain species which react to a mycelium, variations in acidity have no effect in the absence of the fungus, and also that the effect of the fungus in promoting rapid development is evident even when there is no nutrient of any kind in the medium. Similarly the germination of the relevant angiospermous parasite seeds in soil cannot be attributed to an intermediate effect of the roots on the soil or soil solution. Recent workers and notably Barcinsky[21] have observed stimulation when seeds are treated with water that has been percolated through soil carrying the appropriate roots. One of the effects of percolation must be to dissipate any local effect of the roots on the acidity of the soil, and the results of these experiments, therefore, suggest that this factor can have little independent effect on germination. This conclusion is confirmed by the observations of Saunders[4] on the effect of *p*H on the germination of the seed of *Striga lutea*. In percolation experiments using soil the stimulation

observed may, however, still be due to the production in the soil of stimulating substances from the constituents of the soluble and insoluble fractions. This factor, however, cannot operate in experiments such as those of Saunders in which soil is replaced by sand. In these, as in those involving soil, water percolated through the sand induced germination. Confirmatory evidence for the conclusion that the stimulation of the seed of *Striga lutea* is not due to an intermediate effect on the medium is provided by the results of Brown and Edwards[22], who used another experimental technique. These workers cultured host seedlings on distilled water, the plants being supported on the surface with glass floats with their roots immersed in the liquid. After a time the water was withdrawn, applied to seeds of the parasite, and germination observed in due course. In this case where there was nothing originally in the medium to be modified, the stimulation cannot be attributed to any intermediate effect of the host seedlings.

Nevertheless in the experiments of Saunders and Brown and Edwards the roots evidently contributed some factor to the medium, and the results therefore provide direct evidence for the production of some substance by the host root. In other connexions comparable direct evidence for the same conclusion is also available. Burgeff[9] found that germination of orchid seeds was induced by an aqueous medium in which fungus mycelium had been boiled, and that an active substance could be removed from this and other solutions and obtained as a dry material after adsorption on to charcoal. Chabrolin[27] reported that treatment of *Orobanche speciosa* seeds with an aqueous extract of ground root tissue promoted germination.

Biological Nature of the Stimulant

The evidence for the production of substances by the active tissue does not, of course, indicate that these are of the vitamin or phytohormone type. They may exert an effect by acting as a nutrient supply for the germ. The position may be considered in terms of the available evidence on : (1) the probable concentrations of the stimulants in the active solutions ; (2) the rate at which the reaction to the stimulant occurs ; and (3) the characteristics of the substitute stimulants where such are known. All the quantitative tests at present available involve biological activities, and none of the stimulants has been isolated in a pure form. It is therefore impossible to relate particular concentrations to observed activities, but approximate estimates can be made.

Active solutions have been prepared from dry matter separated from original extracts, and these provide some indication at least of the maximum limits of concentration corresponding to observed activities. Schaffstein[19] found with orchid seeds that some stimulation was given by solutions in which the concentration of the active principle could not have been greater than 1 p.p.m. Chabrolin[27] made a similar observation with the seeds of *Orobanche speciosa*, and Brown and Edwards[25] found that peak germination values with seeds of *Striga lutea* were given with a stimulant concentration that could not have been greater than 1 p.p.m., and that some effect could be observed with concentrations that could not have been greater than 0·02 p.p.m. These concentrations are clearly not within the range at which nutrients exert an effect, and they suggest that the substances involved are phytohormones or similar compounds. Observations on the rate at which parasite seeds react to the stimulant are consistent with this interpretation. According to Chabrolin[27], seeds of *Orobanche speciosa* treated with a stimulant solution for 30 seconds gave a percentage germination of 60, and for 60 seconds one of 70. Brown and Edwards[23] investigated the effect of different times of exposure of *Striga lutea* seeds to solutions of the stimulant and found that exposures greater than two hours had no effect on the subsequent germination in water.

With some dependent germs germination has been induced with compounds of known composition. W. Brown[15] found that the natural stimulant for the spores with which he was working could be replaced to a limited extent by ethyl acetate, ethyl malate and ethyl citrate. Noble[20] reported that the spores of *Urocystis cepulæ* germinated with thujyl alcohol, salicylaldehyde, butyric acid and particularly vigorously with benzaldehyde—a solution containing 1·5 p.p.m. of benzaldehyde gave 90 per cent germination with a sample which with water alone remained dormant. Cooper[28] reported that spores of *Colletotrichum gloeosporioides* which normally require stimulation gave an enhanced germination with thiamin, nicotinic acid, ascorbic acid, carotene and lactoflavin. Similarly with pollen grains : Burck[14] found that the germination of *Mussaenda* pollen occurred when traces of lævulose were present in the medium ; Cooper[28] that the pollen of *Carica papaya* germinated when the grains were treated with lactoflavin and ascorbic acid; Brandscheid reported that the natural stimulant for the pollen of a number of species could be replaced with diastase, and recently Addicott[29] has reported that the germination of the pollen of *Milla* is enhanced when *p*-aminobenzoic acid or inositol are provided in the culture fluid. With orchid seeds, stimulation due to particular substances of known composition has not hitherto been reported, and with parasite seeds there is only the single observation of Brown and Edwards[24] that with *Striga lutea* the natural stimulant can be replaced to a limited extent by thiourea and allylthiourea. Many of the substitutes differ from the natural substances by acting more slowly than do the latter and at concentrations which are much higher than those in which the natural substances normally occur. Nevertheless, in relation to the probable biological status of the natural compounds, the characteristics of the substitutes are of some significance. Since no single one of these (with the possible exception of lævulose) could be described as a simple nutrient, it is clearly probable that the natural substances are not of that character either.

Chemical Nature of the Stimulant

As indicated above, none of the stimulants has been identified. It is, however, evident from the characteristics of the substitute stimulants that the natural substances are not simple inorganic compounds, and from the variety of culture media that may be used with certain germs that trace elements are not involved. With *Striga lutea*, for example, the medium may be a solution of inorganic salts, and it may include agar or it may be water percolated through sand or soil; but whatever it is, it is only effective when it has been in contact with the roots of another plant. Clearly, if trace elements were involved some independent effect of one or other of the different media might be expected.

Variety of Activators in Germination of Dependent Germs

The foregoing discussion is framed in terms that suggest that in any particular connexion only a single natural substance is involved, that the stimulation, for example, of the seed of *Striga lutea* is due to a single substance of constant composition that is produced in the roots of a potential host. It must be emphasized that this is an assumption which is not supported by any direct experimental evidence. Justification for the continued use of this assumption as a tentative hypothesis is, however, provided by the two following considerations. As indicated below, stimulation for any one germ may arise from a variety of active tissues. Now, it is clearly improbable that a constant mixture of substances (and such would be necessary to account for the constant reaction) could arise from a number of widely dissimilar tissues, and the fact of a large variety of sources therefore suggests that only a single substance is involved. Secondly, a single substance only is usually involved in processes in which the concentrations and rates of reaction are similar to those of the present series.

On the other hand, it is highly probable that different activators are involved in the stimulation of different germs. Such is indicated by the properties of the different stimulating extracts. Thus, many of the substances that affect spores are volatile, while those that affect seeds and pollen grains are not. The stimulant that induces the germination of *Orobanche cumana* is stable in solution when heated up to 150° C.[21]. In this respect it resembles the hatching factor for *Heterodera schachtii*[16], but differs from the germination factor for *Striga lutea*. According to Saunders[4] the latter is rapidly destroyed by heating in air. Again, the variety of substitute stimulants suggests a corresponding variety of natural activators. But although the stimulations with different germs are probably due to different substances, the available evidence suggests that frequently these are not identical with any of the known vitamins or phytohormones. Brown and Edwards[25] found many of these to be without effect with *Striga lutea*, and Schaffstein[10] stated (1938) that the properties of the orchid stimulant were not those of any then known activator.

Variety of Activating Tissues for each Dependent Germ

It is an important feature of the situation that the source of the activator for any particular germ is not unique. Different tissues from a large number of species may provide the stimulation. W. Brown[15] found that the germination of the spores of a number of fungal species all reacted to fragments of leaves of apple, *Choisya*, and *Ruta*; Wilcoxon and McCallum[20] that the germination of another group was enhanced by small quantities of tomato, orange, apple, and pear juice, by aqueous extracts of lily and gladiolus bulbs and of dahlia and potato tubers; and Noble[30] that spores of *Urocystis tritici* were stimulated by fragments of wheat, rye, peas and beans. Some observations of Brandscheid[13] and of Kehl[31] are relevant in this connexion. The former observed that the germination of the spores of four species increased when they were cultured with the pollen of *Tulipa* sp.; and the latter that a sample of spores of *Psalliota campestris*, which did not germinate in water alone, gave a 100 per cent germination with water containing 'mucus' from the stigma of an orchid.

With angiospermous parasites the position is essentially the same. Heinricher[3] examined the range of species that could stimulate germination in two species of *Lathræa*, and concluded: "Die Keimung der Samen erfolgt warscheinlich auf den verschiedensten Laubholzen". Chabrolin[26] found that the seeds of *Orobanche crenata* react not only to the host *Vicia Faba* but also to the roots of species of *Cicer* and *Trigonella*, which are not attacked. Barcinsky[21] showed that a stimulant that induces germination in the seeds of *Orobanche cumana* is produced by the roots of sunflower as well as by those of the Jerusalem artichoke, which are not attacked. Kusano[2] found that seeds of *Aeginetia indica* were stimulated by a large number of species which are not attacked, and Andrews[34] made a similar observation with regard to *Striga hermonthica*. Brown and Edwards[25] found that the stimulant for *Striga lutea* is produced by solanaceous non-host species as well as by gramineous host species.

Until comparatively recently it was commonly held that for each orchid species stimulation was provided by a single fungal species. Burgeff[6], however, showed that seedlings of *Vanda* were stimulated not only by the normal symbiotic fungus but also by non-symbiotic species of *Penicillium*, and Schaffstein[10] showed that stimulation need not depend on a fungus at all but could be induced with extracts of shoots of *Vicia*, *Æsculus*, *Asparagus* and *Allium*, of coleoptiles of *Avena* and of epicotyls and cotyledons of the pea. With regard to pollen grains, Brandscheid[13] found that stimulation could be observed with stigmatic tissue of species other than that of the grain. With the cysts of *Heterodera schachtii*, Triffitt[17] found that washings from the roots of gramineous species which are not attacked, as well as from solanaceous species which are, may induce hatching.

Moreover, the stimulant for any particular germ may have a wider distribution than the evidence available indicates. In many instances it is probable that failure to observe stimulation may be due not to the absence of an activator but to the presence of an inhibitor. An experimental demonstration of this was provided by Schaffstein[10], who showed that treatment of various tissue extracts with animal charcoal led to the removal of the activator from the solution, the inhibitor being unaffected.

Significance of Stimulation for the Metabolism of the Activating Tissue

The distribution of each of the stimulants is evidently extensive. The fact suggests that the activators may be of importance in the metabolism of the activating tissue as well as in that of the germ. It is significant in this connexion that the activators are produced primarily by actively metabolizing tissues and that they are apparently not products of decay. Workers concerned with the parasitism of *Heterodera schachtii* have found that the most abundant production of the stimulant occurs when the growth of the host is most vigorous. Triffitt[16], after removing fragments from the surface of the root, immersed the root in water for forty-five minutes, then applied the water to cysts and observed hatching as a result. Recently, Ellenby[22] has suggested that there is some connexion between the respiration-rate of the host root and production of the stimulant. Chabrolin[27] found that the stimulant

for *Orobanche speciosa* was released from the piliferous region of the root, and Brown and Edwards[22] that the stimulant for *Striga lutea* diffused into the medium from the root tip. These two latter observations indicate a relation between stimulant production and meristematic activity which may be established through the characteristically high metabolic activity of the latter.

Significance of the External Stimulant Supply for the Metabolism of the Dependent Germ

The wide distribution of each of the activators suggests again that they may be formed in germs which do not require stimulation, and that dependent germs are peculiar only in being unable to synthesize substances which are normally formed during the germination of non-dependent germs. The position is no doubt similar to that of the strains of certain micro-organisms which unlike other strains of the same species cannot synthesize certain necessary factors and must rely on an external supply for full developmental activity. Brandscheid[12] reported that pollen grains which require stimulation may germinate when they are cultured with others which do not—an effect that is no doubt due to the production by the latter of a substance which is not synthesized by the former but which is absorbed by it from the fluid in which they are both suspended.

Schaffstein[10] emphasized the fact that within any group of orchid seedlings giving uniform development with an activator there are large differences between individuals when no activator is provided. These differences, according to this worker, indicate that the necessary activator is synthesized to a variable extent by different individuals and that uniform development is therefore only made when the internal supply is supplemented by an external supply of the same substance. A similar hypothesis is proposed by Brown and Edwards[23] in relation to certain observations on the effects of incubating moist seeds of *Striga lutea* for different periods before exposure to the root stimulant—an experimental process which has been called by these workers 'pretreatment'. In this process as the period of incubation at 22° C. is extended the germination frequency observed with a standard concentration of the stimulant at first increases, until a peak value is reached after about twenty-one days, and then decreases until the germination capacity is reduced to a negligible level. The solution with which this result was recorded was one prepared by culturing ten host seedlings on distilled water in standard conditions of light, temperature and aeration for a standard period of seven days.

Certain incidental observations made by earlier workers suggest (to me) that the phenomenon involved in pretreatment is probably a characteristic of the germination of other dependent germs. Noble[20] found that the spores of *Urocystis cepulæ* gave a higher percentage germination with benzaldehyde after incubation for six days than before it; and that as the period of pre-soaking was increased from one to eight days there was a progressive increase in percentage germination on addition of a section of host tissue to the culture, but that extension for a further period of twenty days (making twenty-eight days in all) depressed germination capacity very markedly. With *Orobanche speciosa* seeds Chabrolin[27] determined the percentage germination after exposure to moisture at a fairly high temperature for one hour, five days and fourteen days, and found it to be 0, 70, and 100 respectively. In this connexion it may be noted that Boyd[23], after soaking *Heterodera schachtii* cysts in water for one, seven, twenty-one and forty-two days, treated them with root stimulant and observed that the proportion of hatches increased with the period of soaking.

The effects of pretreatment with *Striga lutea* have been examined in some detail by Brown and Edwards[23], who showed that when the temperature is changed during pretreatment from 22° to 30° C. during the early phase when the seed is approaching the peak stage, there is an immediate acceleration in the pretreatment process and the peak stage is reached earlier. On the other hand, the same change established during the late phase when percentage germination is decreasing after the seed has passed through the peak stage does not accelerate the rate at which germination decreases; but on the contrary it reverses the dominant trend and tends ultimately to restore the seed to a condition in which peak germination values are again given. Thus it is evident that whatever the nature of the change determining the decrease in germination it is not one that involves the death of a progressively larger number of seeds.

The effects of treating seeds at successive stages of pretreatment with different concentrations of the stimulant are particularly instructive in relation to this problem. In the experiments of Brown and Edwards[23], seed pretreated at 22° C. was sampled at seven, fourteen, twenty-one, twenty-eight, thirty-five and forty-two days, and portions of each sample were treated with a standard solution (prepared as described above) and with concentrations of 1/5, 1/50, 1/100, 1/250, 1/500 and 1/1,000 of the standard. The results showed that at twenty-one days, when the highest germination values are given, a hundredfold dilution of the standard at that stage had no effect on germination; but that at seven and fourteen days when the seed gives low values and when it has still not reached the peak stage, and also at thirty-five and forty-two days when values are again low and the seed has passed through the peak stage, at these stages the slightest dilution has an immediate effect on germination. These results indicate that during the phases of increasing and decreasing germination the concentration of the stimulant is limiting, and that therefore in the early and late phases of pretreatment higher concentrations than that of the standard would probably yield higher percentage germinations.

This conclusion may be considered in relation to the proportion of spontaneous germination that occurs with *Striga lutea*, as with probably most dependent germs. With many dependent fungus spores the number that germinate without stimulation is less than 1 per cent; but with others it may be as high as 50 per cent, and similarly with pollen grains. With parasite seeds Chabrolin[26] states that with *Orobanche cumana* 0·1 per cent germinate without host stimulation; and Brown and Edwards[22] found with *Striga lutea* that the corresponding proportion varied between 0·1 per cent and 10 per cent. In the experiments of Brown and Edwards the highest independent germination was observed at the phase of pretreatment when the highest germination with the stimulant occurred. The pretreatment temperature in these experiments was 22° C., but the seed does not germinate unless exposed to a temperature of 35° C., and thus at intervals the germination in samples pretreated at 22° C. could be determined by transferring them to the higher temperature. By applying this technique it was found that independent as

well as stimulated germination increased with the extension in the period of pretreatment until a peak value was reached, and then decreased with further extension of the period of pretreatment.

From this observation and from the effect of different concentrations of the stimulant at different stages of pretreatment, it may be inferred that a certain critical level of the stimulant must be established in the seed before germination can occur, that part of this quantity is contributed by the seed itself and part by an external supply, and that during pretreatment there is at first a gradual accumulation of the stimulant until a maximum quantity is formed and then a dispersal of the accumulated reserve. It may be suggested that as pretreatment proceeds the increasing germination with a standard concentration of the stimulant is the result of a complementary accumulation of the same or a closely allied substance in the seed; and conversely that the decreasing germination is due to a decreasing quantity in the seed which is not compensated by an increasing concentration outside it. The amount in the individual seeds at any stage of pretreatment no doubt varies considerably, and at all stages the variation must involve some seeds that can provide the whole of their own stimulant requirement; the number of these seeds must vary, of course, with the average stimulant content of the sample, hence probably the general correspondence between change in stimulated and independent germination during the course of pretreatment.

Summary

There is abundant evidence to show that with certain fungal spores, pollen grains and seeds, germination will not occur when external supplies of particular activators are not available. Normally the activators are produced in actively metabolizing tissues from which they are released into an aqueous medium, and from which in turn they are absorbed by the appropriate spores, pollen grains or seeds. The evidence indicates that different activators are involved in the stimulation of different dormant tissues, and that each activator may be produced in the tissues of a large number of species. It is suggested that the activators are of importance in the metabolism of the stimulating as well as of the stimulated tissue, and the hypothesis is proposed that the dependence of the latter on an external supply of the activator is due to a failure to synthesize this or a similar substance. Tissues that do not require stimulation differ from those that do in synthesizing the essential substances in the course of development.

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OBITUARIES

Prof. B. A. Keller

Prof. Boris Alexandrovitch Keller died in Moscow on October 29 at the age of seventy-one. He was a member of the Academy of Sciences of the U.S.S.R. and he was well known all over the world as the author of important works on geobotany and ecology.

Keller was born in St. Petersburg on August 28, 1874. He passed his childhood and youth on the Volga. The Volga landscape, and the broad steppes, made a deep impression on the young student, and he preserved all his life a special affection for, and interest in, the vegetation of steppes and semi-deserts. He graduated from the University of Kazan in 1902. Even in his undergraduate days he conducted researches in plant geography under Gordiagin. For eleven years he worked in the University of Kazan, first as assistant and later as *dozent*.

When the Voronejh Agricultural Institute opened in 1913, Keller was appointed to the chair of botany there. He held this post until 1931, when he was elected a member of the Academy of Sciences. He then became the director of the botanical institute of the Academy of Sciences, the most important botanical appointment in the U.S.S.R., formerly the St. Petersburg botanical garden. In 1936 Keller moved to Moscow, where he was entrusted with the organi ation of the new Moscow botanical garden. This post he held until his death.

In 1897 Keller began his plant geographical researches of the lower Volga, and in 1907 he published a remarkable book, "Semi-desert Regions", written in collaboration with a soil scientist, Dimo. In this book he first applied the now familiar method of 'ecological sequences' in describing vegetation; he also used the concept of vegetation complexes, later called "Sinuzia". Other work of Keller was conducted in western Siberia and the Altai Mountains. When he worked in Voronejh he brought out an excellent book on the vegetation of south-east Russia.

The chief characteristic of Keller's geobotanical researches is the emphasis he lays on ecological aspects. In his work on the Russian steppe he always allots a conspicuous place to the study of soil and climatic conditions and their determining effect on the vegetation; and in his work on halophytes he entered with distinction the field of experimental ecology. Keller founded at Voronejh an experiment station, where he continued to work intermittently even after his transfer to Leningrad.

In recent years, Keller interested himself in the study of evolution, particularly in ecological work bearing on evolution. It appears from his recent papers that he considered that environmental characters exerted some effect upon inherited modifications, though he did not under-rate the importance of natural selection, and he remained an ardent adherent of Darwinism.

Keller took part in international congresses of botany and soil science, and he published articles not only in Russian but also in several foreign periodicals. At the time of his death he was widely known and esteemed by botanists all over the world.

N. A. Maximov.

(Translated by E. Ashby.)

I should like to add to Maximov's note a personal tribute to B. A. Keller. I called on him in his flat in Moscow early in 1945, and he gave me a friendly and generous welcome. He was a sick man, but he was enthusiastically working at a book on ecology and evolution. He was very anxious that I should become familiar with the flora around Moscow, and to that end he gave me his own copy of the handbook to the local flora, and instructions as to the places I should visit. We met several times during the year, and Keller was always willing to help me. I attended his funeral ceremony in the biological block of the Academy of Sciences; and it was clear from the speeches made there by his students and by a representative of workers from the botanic gardens, that Keller had great influence upon the younger generation of botanists, and that his name is not only honoured but also held in deep affection by those who knew him.

E. Ashby.

Dr. J. M. Derscheid

The death has recently been confirmed of Dr. Jean-Marie Eugène Derscheid, professor of biology of the Colonial University of Antwerp, who was shot at the prison of Brandebourg on March 13, 1944, after thirty months imprisonment in Germany.

Derscheid was born at Sterrebeek on May 19, 1901, and from earliest youth showed a great propensity for natural sciences and art. At the age of seventeen he interrupted his studies to endeavour to join in the fighting by attempting to pass through Holland and reach the front behind the Yser, but was taken prisoner and was not liberated until the Armistice in 1918. In 1919 he began studying medicine, but later changed to take a degree in natural sciences.

In 1924 Derscheid was awarded the gold medal of the *Concours Interuniversitaire* for the period 1922–24 for his theses on the classification of birds and the olfactory organs of fish. During 1924–26 he acted as temporary keeper of the Colonial Museum at Tervueren, and in 1926 was appointed by the King of the Belgians to accompany the American expedition led by Carl Akeley to explore the volcanic region of Kivu. On the death of Carl Akeley, Derscheid took charge of the expedition, and the information he obtained contributed greatly to the creation of the Albert National Park, the first national park of the Congo. In addition, he was chief of the International Office for the Protection of Nature in Brussels.

Derscheid specialized in the fauna of the Belgian Congo, among the most important of his papers being "Recherches anatomiques sur l'Okapi. 1, Le caecum et la glande ileocaecale. 2, La rate" (*Revue de Zoologie et Botanique Africaine*).

He was also a singularly successful aviculturist and his collection of birds at Sterrebeek was justly world-famed. He was also no mean artist, and many of his ornithological articles were illustrated by his own drawings.

Derscheid was a fellow of the Zoological Society of London and of the Audubon Society of America, an honorary life-member of the Wild Life Preservation Society of Australia and was awarded the medal of the Société d'Acclimatation de France.

In 1940 Derscheid rejoined his regiment, and having fought into France was demobilized and returned to Belgium in the autumn of 1940. His perfect knowledge of English made him an invaluable aid to escaping British airmen, and in addition he gave considerable service in sending secret information to the Allies, with the result that he was arrested by the Gestapo in October 1941.

The tragic end of Derscheid's career will be both a loss to science and a grief to his colleagues, who will long remember his peculiar charm of manner and vital personality.

Phyllis Barclay-Smith.

Mr. A. J. W. Selley

Alfred John William Selley died at Arundel, Sussex, on November 28 at the age of ninety-one. Born in Devon, Mr. Selley went to Bristol as a young man in 1874 and lived there until the war period.

Selley was a brilliant and ardent collector, and many exhibits in the City Museum, Bristol, are a silent witness to his devoted services over so many years. At first he concentrated on the surface flint implements of the Mendip area. He was intimately acquainted with the district and often would spend a whole day traversing and re-traversing a ploughed field so that every portion of it was inspected. Later in life he also took an interest in bygones of all ages, and due entirely to his passion for collecting, many an interesting object has been preserved. Science and history owe much to those who devote their leisure hours to the acquiring of facts and material. Selley was one of this small but energetic group.

Selley was a member of the Bristol Naturalists' Society for many years and was made an honorary member in 1939 in view of his distinguished services to the cause of local prehistoric studies. He was retiring and modest; he was essentially an individualist and loved to be alone in the open field for long hours searching for any object that awaited his keen observational powers.

F. S. Wallis.

We regret to announce the following deaths:

Prof. A. M. Adamson, professor of entomology in the Imperial College of Tropical Agriculture, Trinidad, on December 24, 1945, aged forty-four.

Dr. P. Amaury-Talbot, an authority on Nigeria, on December 28, 1945, aged sixty-eight.

Dr. Thomas Barbour, director of the Museum of Comparative Zoology and professor of zoology, Harvard University, who was a foreign member of the Zoological Society of London, on January 8, aged sixty.

Dr. Leo Cernosvitov, a specialist on Oligochaete worms, on December 15, 1945, at Ascot.

Mr. R. C. Shannon, entomologist of the International Health Division, Rockefeller Foundation, and an eminent American authority on mosquitoes, in Trinidad, on March 6, 1945.

NEWS and VIEWS

Carbon-13

FIVE isotopic forms of the element carbon are known, having atomic weights ranging from 10 to 14. Two of them, C^{12} and C^{13}, exist stably in Nature, while the others are radioactive, and are known to us only through their production in various nuclear reactions. The recent great development in the techniques of isotope separation have made it possible to produce substantial quantities of carbon compounds in which the ratio of C^{13} to C^{12} has been increased far beyond the 1·1 to 98·9 characteristic of natural carbon. This will be important in chemical and biological research, for C^{13}, being chemically the same as natural carbon, but distinguishable from it by the sensitive techniques of mass-spectrography, may be used as a 'tracer' to follow the history of carbon atoms in their passage through chemical and biochemical reactions. For example, if a small quantity of C^{13}-enriched sugar is eaten by or injected into an animal, the distribution and state of chemical combination of the carbon of this particular dose may be determined by measuring the C^{13}–C^{12} ratio of appropriate specimens taken from the animal at a later date. The importance of C^{13} is all the greater because two of the three radioactive isotopes of carbon decay too rapidly to be suitable tracers, while the remaining one (C^{14}) has so long a life (3,000 years) that its detection by radioactive methods is relatively insensitive.

It is understood that C^{13} is to be produced in quantity by the Sun Oil Company and the Houdry Process Foundation at plants situated near Philadelphia in the United States. The process employed will be that devised by Prof. H. C. Urey (formerly professor of physical chemistry at Colombia University, New York, and now at the Institute of Nuclear Studies, Chicago), and Dr. Allen Reid. Material will be provided free to qualified non-commercial biological and medical research organizations "which can justify such donations". The Medical Research Council is endeavouring to arrange for the supply in the United Kingdom of this and other isotopic indicators, including radioactive species of all elements of biological significance. Facilities for analysis by mass-spectrographic methods and by counter technique must be made available to workers wishing to employ isotopic tracer methods in their investigations before these can have any wide application.

British Association Secretaryship: Mr. D. N. Lowe, O.B.E.

MR. D. N. LOWE, who has been appointed to succeed Dr. O. J. R. Howarth as secretary of the British Association (as already reported in *Nature*) after the first post-war meeting of the Association, is a Scot and is thirty-six years of age. As a Kitchener Scholar he studied at the University of St. Andrews, where he graduated M.A. (literature and history) and B.Sc. with first-class honours in botany. He was president of the Union, of the Students' Representative Council, and of the Mountaineering Club of the University. After a short period of research on the marine algæ of Fife, he was appointed assistant secretary of the British Association in 1935. Shortly after the outbreak of war he was seconded for national service. On the secretariat successively of the Ministry of Supply, the Ministry of Production and the Cabinet, he has served as administrative secretary to various Whitehall committees concerned with priority and allocation of materials, and was awarded an O.B.E. in the recent New Year's Honours List.

Wool Research in Australia

THE passage of the Wool Use Promotion Act (1945) through the Commonwealth Parliament is an Australian reaction to what is commonly termed the threat of synthetic textile fibres to wool. This Act is supplemented by a Wool Tax Act (1936–1945) which imposes a levy of 2*s*. per bale, payable by the grower, on all wool received or produced by a wool-broker or dealer, or exported on and after June 1. The proceeds of the levy (estimated at £300,000 in a normal year, but considerably less in 1945–46) are to be paid into a Wool Use Promotion Fund. In addition, a Wool Research Trust Account is established into which the Treasury will pay annually from consolidated revenue a sum equal to that raised by the levy. The total available may therefore reach as large an amount as £600,000 per annum. A committee of Ministers will determine each year what sum (if any) shall be transferred from the Promotion Fund to the Research Account. The balance left in the Fund will be applied by the Australian Wool Board to promoting, by publicity and other means, the use of wool in Australia and throughout the world, and for performing such other functions for the benefit of the wool industry as may be approved by the Ministers.

The Research Account, the minimum sum in which will be the equivalent of the 2*s*. levy on the clip, is to be applied, according to the Act, for "scientific, economic and cost research in connection with the production and use of wool and goods made wholly or partly from wool; and the co-ordination and application of the results of any such research". It is understood that the Council for Scientific and Industrial Research will undertake full responsibility for all scientific work. Its present programme of investigations on the production side will be considerably increased, and it is probable that a new division will be set up to handle a wide diversity of problems associated with the manufacturing side. Detailed plans are at present under discussion.

New Method of Sound Recording

FOR many years past it has been the practice with broadcasting organisations to record sound programmes for reproduction as and when required. In some cases this technique makes use of ordinary gramophone records or of metal disks coated with a preparation of cellulose acetate. In other cases, the sound programme to be recorded is made to influence the longitudinal magnetization of a continuous steel tape which passes under the recording head. This latter process is suitable for long programmes, which can either be reproduced immediately or after an interval, the tape being rewound and passed under a suitable magnetic pick-up. The recording can afterwards be effaced or 'wiped off' the steel tape by a demagnetization or saturation process, and the tape can thus be used many times for different programmes.

According to a recent report in *The Times*, an examination of the equipment in use at broadcasting stations in Germany indicates that the Germans were ahead of Britain and the United States of America

in this technique of sound recording, in so far as a wider range of acoustic frequencies could be recorded with an absence of background noise such as hum and scratch. In the German magnetophone equipment, the recording medium is a plastic ribbon sprayed with a magnetic material in solution; this is much lighter and less bulky than the steel tape referred to above, and also has the advantage that imperfections can be removed and editing effected by cutting out the unwanted portions of the ribbon with scissors and sticking together again with a special fluid which sets almost immediately. The magnetic recording process would appear to be the same for the coated ribbon as for the steel tape, and while this magnetized ribbon can be kept indefinitely, it can as required be 'wiped clean' by passing it through a high-frequency magnetic field, after which the ribbon is ready for recording a new programme.

Manufacture of Radio Equipment in India

THE August issue of the *Journal of Scientific and Industrial Research* published in Delhi contains an article by S. P. Chakravarti entitled "Manufacture of Wireless Apparatus in India". The growth of radio in India began in 1926, when two low-power broadcasting stations were set up in Bombay and Calcutta. In the following seven years radio telegraph and telephone beam stations were installed linking India with Great Britain and later with Japan. Since 1936, a broadcasting service has been operated on progressive lines under a separate department known as All India Radio. In spite of these developments, however, the production in India of radio equipment, including broadcasting receivers, prior to the outbreak of war in 1939, was confined to the assembly of sets from imported parts and components. In the following years these imports became increasingly difficult to obtain, and many firms had to abandon the manufacture of radio sets. In 1942, a systematic examination of the manufacturing position was carried out by the Government of India in connexion with the development of military radio sets. Investigations leading to the development of certain components from materials available in India have since been carried out under the auspices of the Radio Research Committee of the Board of Scientific and Industrial Research. It is now known that sufficient facilities for the manufacture of all components except valves exist in India, and that the organisations—some twenty in number—possessing manufacturing facilities are in urgent need of special basic materials and appliances.

The article referred to above gives details of these materials, and also a summary of the present manufacturing position of such components as carbon resistors, fixed and variable condensers, loudspeakers, transformers and vibrators. The need for the production of valves in India is stressed; and it is suggested that two factories, in the north and south respectively, should be immediately established for the production of valves with the aid of machinery imported from the United States or Britain. The number of radio receiving sets in India in 1944 was about 0·5 per 1,000 persons, and it is proposed that this should be increased to two sets per 1,000 persons during the next five to ten years by a production of about 100,000 sets a year. This is additional to the manufacture of large quantities of parts and replacements needed for maintaining and servicing about 200,000 broadcasting receivers and a number of communication receivers already in use in the country. In addition to the home consumption, the neighbouring countries—Burma, Malay States, Ceylon, China, Afghanistan and Persia—all of which have their own broadcasting stations, and also receive transmissions from India, may buy annually a total of 50,000 sets and a large number of components for their maintenance.

A New Gem Stone

A NEW mineral, brazilianite, which has possibilities as a gem stone, has just been announced jointly by Edward P. Henderson, of the Smithsonian Institution, and Frederick H. Pough, of the American Museum of Natural History. Obtained by Dr. Pough in Brazil from the owner, who thought it was chrysoberyl, the mineral on examination proved to have a different crystal habit from chrysoberyl, or from any other mineral. Brazilianite, which has been named after its country of origin, is a new monoclinic phosphate mineral, $NaAl_3P_4O_{16}(OH)_2$. It is a yellowish-green, glass-like mineral sufficiently good in colour and physical perfection to make it suitable for cutting into gem stones, although it is believed that it is not likely to become a popular gem because of its scarcity and lack of sufficient hardness to enable it to withstand much wear. Brazilianite is believed to be the first new mineral with gem-stone possibilities to be discovered since 1909, when benitoite was found in California. Messrs. Pough and Henderson have described brazilianite in a paper, with an illustration in colour, in the *American Mineralogist* (30. 572; 1945).

Dutch Pharmacy under the German Occupation

PHARMACEUTICAL conditions in Holland under the German occupation were reviewed in a lecture given before the Pharmaceutical Society of Great Britain on December 13 by Dr. C. J. Blok, chief pharmacist to the University and municipal hospitals of Amsterdam. About 1943, said Dr. Blok, many articles became so scarce that the General Office of Public Health found it necessary to limit the prescribing of the doctors. Cod liver oil was only to be prescribed for tuberculosis; atropine only for Parkinsonism and eyedrops; pilocarpine only for eyedrops; luminal only for epilepsy; pepsine for serious stomach cases; dermatol only for epilepsy. After the Germans had robbed the safe of the Organon factories, insulin also became very scarce. Dr. Blok went into considerable detail regarding the means taken to economize alkaloids for eye treatment, including the use of ointments instead of solutions. In September 1944 came the loss of gas and electricity, which meant that sterilization in operating rooms by heat had to be reduced to a minimum as the spirit and petrol which might have been employed were very scarce. Fortunately he himself had steam autoclaves by which sterile injections could still be prepared. Operating rooms had to resort to chemical sterilization with 4 per cent 'Lysol', or a mixture of borax carbol-formalin with a little sodium nitrite against rusting; a very stable solution with quite effective sterilizing powers was 2 per cent formalin, 2·5 per cent phenol, 1·5 per cent borax. Another difficulty was the impossibility of melting ampoule glass, due to lack of gas. This was overcome by using an acetylene lamp made from an ordinary bottle; the temperature obtained was enough to melt glass, and the apparatus was used at home as a lamp.

The Mosquitoes of Uganda

In the *Bulletin of Entomological Research* (**36**, Pt. 1; 1945), A. J. Haddow of the Yellow Fever Research Institute, Entebbe, discusses the mosquitoes of the Bwamba country, Uganda. The work has special reference to a single species—*Aëdes* (*Stegomyia*) *simpsoni* Thea.—which appears to be the main carrier of the virus of yellow fever among human beings in the territory just mentioned. Ecological studies showed that forest was cooler and moister by day than a banana plantation, while the latter was cooler and moister than the open air. At night, however, the climate of all three environments was strikingly similar. Experimental catches made over 24-hour periods and large-scale routine catches were carried out. As the result it appeared that *Aëdes simpsoni* bites mainly in coffee gardens, maize fields and in the thinner parts and fringes of banana plantations. It is scarce in exposed situations and prefers the blood of man to that of goats, fowls or monkeys. It is demonstrated that many forest mosquitoes occur in banana plantations. Analysis of day and night catches seems to point to their migrating into plantations, from the forest, at night time. The results of catches in forest and banana plantations show that there are two types of biting cycle. In one there are two main peaks of activity in twenty-four hours, usually about sunrise and sunset. In the other there is a single peak of activity in twenty-four hours which may occur by day or by night. It is suggested that these cycles are dependent on features of the microclimate, and the findings are believed to have a bearing upon yellow fever epidemiology.

The National Trust: Annual Report, 1944–45

The annual report for 1944–45 of the National Trust contains a list of properties owned or protected by the Trust. The mode of acquirement (or nature of control), acreage and history are briefly noted under each property heading. This list is both timely and useful; but it would have been of greater use for reference purposes had the sites been classified under county headings. As it stands, a person unacquainted with local names will have to examine sixty-eight pages before he can discover what properties the Trust owns or controls in, say, Cornwall. The index at the end of the list is no more helpful in this respect. The report preceding the property list summarizes work and development during the past fifty years. Few will read it without feeling gratitude towards the Trust and the large number of public-spirited donors whose work and generosity have made possible the preservation of so many places of historic interest and natural beauty in Britain for the cultural and recreational enjoyment of the nation.

Regional Research Station in N.S.W.

To facilitate study of problems associated with the development of irrigated pastures and forage crops on the heavy grey and red-brown soils of the Riverina district of New South Wales, Messrs. F. S. Falkiner and Son have presented 1,550 acres of typical country to the Australian Council for Scientific and Industrial Research. An experimental farm will be established, with laboratory facilities, some twelve miles away in the town of Deniliquin. Water will be provided by the State Water Conservation and Irrigation Commission. It is hoped to deal there with many of the plant and animal production problems affecting one of the most important agricultural areas of the Commonwealth.

Announcements

The Gold Medal of the Royal Astronomical Society has been awarded to Prof. Jan H. Oort, director of the Leyden Observatory, for his investigation of the dynamics and rotation of the galactic system. A Jackson-Gwilt Medal and Gift has been awarded to Mr. H. W. Newton, of the Royal Observatory, Greenwich, for his work on the sun, notably on the relation between solar flares and magnetic storms.

Dr. E. B. Worthington, director of the Freshwater Biological Association's station on Lake Windermere, has been appointed joint secretary to the Colonial Research Committee. It is intended that Dr. Worthington should be available for extensive travel in the Colonies and assistance to colonial authorities in matters of research, and it is expected that he will go to East Africa soon for this purpose.

Dr. H. S. Holden, director of the East Midland Forensic Science Laboratory, Nottingham (formerly professor of botany in University College, Nottingham), has been appointed to succeed Dr. J. Davidson as director of the Metropolitan Police Laboratory on April 1.

Balliol College, Oxford, is making an election, not later than October 1946, to a research fellowship of the annual value of £300 without restriction as to subject. Candidates must have taken a degree at Oxford or at some other university. The tenure of the fellowship does not necessarily exclude the holding of some other post approved of by the College, and will in the first instance be for three years, with the possibility of re-election. Further details may be obtained from the Secretary, Balliol College, Oxford. Applications must be received by May 1.

It is hoped to make this year a limited number of appointments to Commonwealth Fund Fellowships tenable in the United States. Before the War, there were three categories of the fellowships, namely, ordinary, Service (for British Government servants overseas) and home Civil Service (for Civil servants in Britain), but only ordinary fellowships are to be awarded in 1946. Candidates must be of British descent, university graduates, and less than thirty-five years old; no women will be considered. Applications must reach the secretary of the committee of award, Mr. Richard H. Simpson, Commonwealth Fund Fellowships, 35 Portman Square, London, W.1, by February 28.

The Clough Memorial Research Fund of the Edinburgh Geological Society was instituted in 1935 for the purpose of encouraging geological research in Scotland and the north of England (the latter being defined as the counties of Northumberland, Durham, Cumberland, Westmorland and Yorkshire). Approximately £30 is available annually. Applications for grants are invited for the period April 1, 1946–March 31, 1947; they must be in the hands of the Secretary, Clough Memorial Research Fund Committee, Edinburgh Geological Society, Synod Hall, Castle Terrace, Edinburgh, not later than March 1.

Prof. H. S. Carslaw asks us to state that he has prepared, in association with Dr. J. C. Jaeger, a new wo k based on, but superseding, his "Introduction to the Mathematical Theory of the Conduction of Heat in Solids". He therefore regrets the appearance of a reprint of his older book recently announced by Dover Publications, permission for which was given before he was consulted.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Bacterial Cellulose for Osmometer Membranes

In the investigation of the mechanism of polymerization reactions, it is essential to be able to count the number of polymer molecules produced. This implies that the number average molecular weight has to be measured. The best method is to use an osmometer, taking precautions with regard to the extrapolation of measurements to infinite dilution. Further, in order to get results reasonably quickly, the so-called dynamic osmometer is most suitable; but the difficulty here is to get membranes which allow the solvent to diffuse through rapidly, but which are impermeable to the polymer molecule.

Fuoss and Mead[1] have recommended denitrated collodion for this purpose, but it may be of interest to describe the behaviour of another membrane which has proved suitable for molecular weight determinations of vinyl polymers up to values of 200,000. This is a variety of cellulose elaborated by *Acetobacter xylinum*, and is prepared according to the method of Aschner[2]. Briefly, *Acetobacter xylinum* N.C.T.C. 1375 is grown at 30° C. in a vessel of convenient size and shape containing a sterilized medium composed of yeast extract, acetic acid, sucrose and alcohol to a depth of about two inches. Initially, the organism grows in the form of a loose web throughout the medium, ultimately forming a rather irregular film on the surface. This first film is removed with aseptic precautions and discarded, thereby removing the bulk of the fine particulate matter suspended in the medium. On subsequent incubation a second film of surface growth appears within twenty-four hours. This is quite regular and is left for three to four days, by which time the membrane is about 4 mm. thick. The membrane is removed, rinsed in water, and treated with 5 per cent caustic soda at 37° C. for twenty-four hours. Subsequent washing for twenty-four hours in running tap water removes the dissolved bacteria and excess caustic soda, leaving a neutral, translucent and tough membrane of pure cellulose. If such membranes are washed successively with alcohol and with benzene, they are far too permeable for use in the dynamic osmometer, even to polymethyl methacrylate molecules of molecular weight of about 300,000. On the other hand, in the dry state the membranes are completely impermeable to organic solvents like benzene. It is evident, therefore, that some control can be exercised over the permeability between these two extreme values, and therein lies the usefulness of bacterial cellulose. The following procedure has been found satisfactory for benzene solutions of polyvinyl compounds with molecular weights exceeding 10,000.

A membrane made from a new culture of bacteria is dried at room temperature by squee-geeing it on to a plate of highly polished stainless steel. When dry it is peeled from the surface and then immersed in distilled water. (If the membrane sticks to the plate, it can be more easily removed by immersion for a short period in distilled water.) Next, the membrane is washed in four or five changes of ethyl alcohol over a period of two hours and then allowed to stand in absolute alcohol for half an hour. Finally, the membrane is washed in three or four changes of benzene (or other organic solvent) to displace the alcohol. The membrane is then ready for use, and should be kept stored under benzene when not in the osmometer. Even then, such membranes gradually lose their permeability, and at room temperature permeability to benzene decreases by a half in two months. With the dynamic osmometer, readings of osmotic pressure could be obtained in thirty minutes in two runs on either side of the equilibrium point. The rate of penetration of polyvinyl acetate of an average molecular weight of 114,000 with a membrane 15 cm. in diameter and a cell depth of 0·2 cm. was less than 0·1 per cent in two hours, and even after fifteen hours only about 1 per cent of the polymer had diffused through. With another sample of polyvinyl acetate, molecular weight *c.* 20,000, penetration was negligible after two hours. These membranes when new do not exhibit any asymmetry by giving rise to a cell constant; but during prolonged use a cell constant of a few millimetres of benzene does develop. This can be kept at a minimum by washing the membrane with the solvent used for the osmotic experiments.

Further details of these experiments will be published elsewhere.

Our thanks are due to the director of the Research Laboratory of the General Electric Company for kindly supplying the glass-metal seals used in constructing the osmometer.

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[1] Fuoss and Mead, *J. Phys. Chem.*, **47**, 59 (1943).
[2] Aschner, M., *J. Bact.*, **33**, 249 (1937).

Supersonic Vibration Potentials and Centrifugation Potentials

These two electrokinetic effects have recently been found in this laboratory, the first with the collaboration of Prof. Cnops and Mr. J. Vidts, the second by my collaborator, Mr. G. Jacobs. Mr. Vidts and Mr. Jacobs will give a more detailed account of their work in the *Koninkl. Vlaamsche Acad. voor Wetenschappen*.

As for the supersonic vibration potentials, Debije[1] pointed out in 1933 that if supersonic vibrations are introduced into the solution of an asymmetric electrolyte, the difference in inertia between the two sorts of ions will cause electric potential differences of some μvolts in the solution, which should be detectable after amplification. In 1938 attention was directed to the fact[2] that this Debije effect might be multiplied by a factor 10^4 if a colloidal solution was chosen as an asymmetric electrolyte. At the same time the experimental research for the effect was started; it was interrupted by the outbreak of war, and taken up again in the beginning of 1945.

The amplitude of the alternating potential difference in a colloidal solution is approximately given by the formula

$$\psi_0 = \frac{mnD\zeta v_0 g}{4\pi\eta\sigma}. \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where ζ is the electrokinetic potential of the colloidal particles, mn their mass per cm.^{3}, D the dielectric constant, η the viscosity, σ the specific conductivity

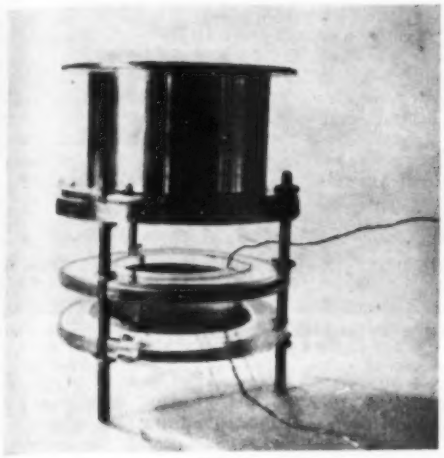

Fig. 1.

of the colloidal solution, v_0 the velocity amplitude of the particles of the liquid, and g the velocity of sound in the liquid.

With $mn = 0{\cdot}065$ gm./cm., $\zeta = 50$ mV., $D = 80$, $\eta = 0{\cdot}01$ gm. cm.$^{-1}$ sec.$^{-1}$, $\sigma = 10^{-4}$ ohm^{-1} cm.$^{-1}$ $\cong 10^{5}$ E.S.U., $g = 1{\cdot}5 \times 10^{5}$ cm./sec., $v_0 = 3$ cm./sec. (corresponding to the acoustical radiation pressure of 5 dynes/cm.^{2} actually observed) one would expect $\varphi_0 = 10$ mV., a large value indeed as compared with the value of some μvolts expected for an electrolytic solution.

Our quartz was in the form of a circular disk of diameter 55 mm., thickness 8 mm., and had a characteristic frequency of 289 kilocycles (corresponding electromagnetic wave-length 1,030 m.; corresponding supersonic wave-length in water 5 mm., in brass 10·2 mm.). It was coated on both circular faces with a silver layer of 175 mgm., with which the electrodes, two light, elastic rings of brass, made contact (Fig. 1); the whole system was immersed in oil.

The alternating tension, up to a maximum of 5,000 volts, was obtained from an oscillator with two Phillips 250-watt transmitting tubes *TC*2/250 in push-pull connexion, class *C*; the wave-length was adjustable between 1,000 and 1,100 metres by means of a variable air-condenser.

The glass vessel containing the colloidal solution was mounted inside an earthed brass case, in order to secure protection against the electromagnetic radiation from the oscillator. The bottom of the case consisted of a brass plate of 5·1 mm. thickness (equal to $\lambda/2$ in brass), permitting the passing of supersonic waves from the oil, surrounding the quartz, towards the oil filling the brass case.

The alternating potential to be measured was picked up by a system of three parallel equidistant wires (distance 2·5 mm.), of which the two outer ones were connected with each other; the tension between this unit and the middle wire was conducted to the amplifier.

The amplifier was of the superheterodyne type; in the first stage, the frequency was transformed from 300 kc. to 450 kc. (triode heptode *ECH* 21); this frequency was amplified in two subsequent middle frequency stages (with pentode *E.F.* 22). Thus there could be no influence of the oscillator upon the last two stages. We obtained an average amplification of 120,000, with a circuit noise of 0·3 volts.

In order to make sure of our results, a brass reflector was mounted in the colloidal solution, so that, besides moving waves, stationary supersonic waves were also generated in the solution; the pick-up was attached to a micrometer screw, so that it was accurately movable in a vertical direction. Now the moving waves will produce a certain alternating potential on the pick-up, irrespective of its position; whereas the stationary waves will produce an alternating potential, the amplitude of which will vary periodically, if the pick-up is moved upwards through the solution.

A blank experiment with a solution of potassium chloride of the same conductivity as the colloidal solution gave an alternating potential difference with an amplitude of 1·5 volts. The experiment was then repeated with the colloidal solution (of silver iodide); we found an amplitude, which changed periodically between 10 and 14·5 volts, when the pick-up was steadily moved upwards; there was a distance of 3 mm. ($\sim \lambda/2$) between two minimum (or maximum) positions of the pick-up; we ascribe the minimum of 10 volts to the moving waves, and the variable part to the stationary supersonic waves.

After division by 120,000, we find an effect in the solution of only 0·1 mV., a hundred times less therefore than the magnitude expected from our formula.

We now turn to the centrifugation potentials. We propose this name for the potential differences existing between radially separated points in a colloidal solution which is being centrifuged.

Centrifugation of a colloidal solution of silver iodide, for example, will cause the heavy silver iodide particles to assume a velocity away from the axis. As the colloidal particles carry an electric charge, this material current represents at the same time an electric current; this current causes a longitudinal potential gradient in the centrifugation tube, given by

$$\frac{d\varphi}{dr} = \frac{nm'\omega^2 r D\zeta}{4\pi\eta\sigma}, \quad . \quad . \quad . \quad . \quad . \quad (2)$$

where m' is the apparent mass of the colloidal particle, ω the angular velocity of rotation (in radians), and r the distance from the axis.

This formula leads us to expect a potential difference per cm. of 17·5 mV. for the colloidal solution

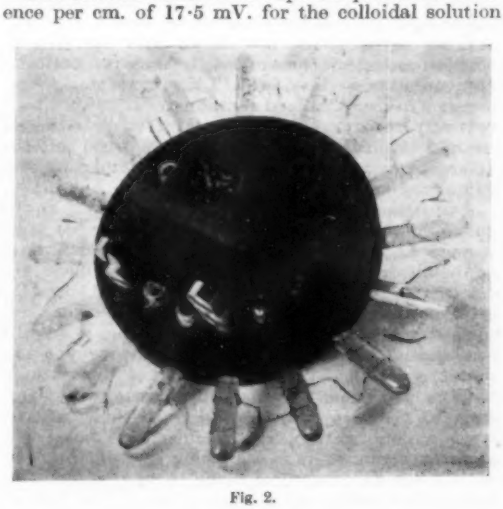

Fig. 2.

considered before, rotating at 3,000 cycles/minute ($\omega = 50 \times 2\pi$), and with $r = 10$ cm.

We mounted sixteen tubes upon the head of the centrifuge; in each tube two platinum wires were sealed in, 1 cm. apart; all these elements were connected in series; in this way the effect was multiplied by a factor 16. The two terminals were connected to the inner rings of two ball-bearings, mounted on the axis of the centrifuge; the outer rings, which remained at rest during centrifugation, were connected with a Cambridge electrometer valve potentiometer (Fig. 2). A blank experiment with an electrolyte solution of the same conductivity gave, besides a constant polarization, only some 40 mV. at top speed (3,000 cycles/minute). The experiment with the colloidal solution of silver iodide gave potential differences which were approximately proportional to ω^2, and which amounted to 250 mV. at top speed.

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[1] Debije, P., *J. Chem. Phys.*, **1**, 13 (1933).
[2] Rutgers, A. J., *Physica*, **5**, 46 (1938). Hermans, *J. J., Phil. Mag.*, (7), 674 (1938).

'Stimulation Crystals' and Twin-formation in Recrystallized Aluminium

Aluminium plates with large crystals, obtained by recrystallization of fine-grain material, show many crystals with a particular type of grain boundary: they appear as 'pointed' inclusions at the edge of large crystallites. In Fig. 1 a few examples of such 'pointed' crystals are indicated by *C*. From an analysis by Sandee[1] (cf. also refs. 2 and 3) of the forms of the grain boundaries which may occur in recrystallized plates, assuming for each crystallite a constant linear growing velocity in all directions, it follows that such crystals have grown as a result of 'stimulation' by another crystal, so that their growth did not start until another crystal, the growth of which had started previously, reached the nucleus of the 'stimulated' crystal. In order to obtain a measurable size, the velocity of growth of the stimulated crystal must, at least at the beginning, be larger than that of the stimulating crystal.

X-ray investigation has shown that the relation between the orientations of both crystals is practically always that of a spinel-twin. Twinning is thus rather common in recrystallized aluminium. It has not been generally recognized on account of the absence of straight twin boundaries, a consequence of the difference in velocity of growth of stimulating and stimulated crystal.

As to the physical aspect of 'stimulation' in the above sense, for the moment the following has been suggested. Stimulating and stimulated crystal have an octahedral plane (111), and in this plane the direction [110] is common. This plane and direction are those used in the glide process of the cubic face-centred metals. Suppose gliding along a definite combination has taken place in a lattice-region: this means, according to present views, that 'dislocations' have moved along this plane over certain distances and are then arrested, together with their fields of stress, at definite structural 'irregularities' (flaws, etc.). Suppose, again, there is a growing crystal, which by chance has an octahedral plane in twin orientation with regard to the active glide-plane of the lattice-region considered above. Then as soon as contact is established between the growing crystal and the deformed lattice-region, something like a 'discharge' of the arrested dislocations along the octahedral plane of the growing crystal might perhaps be conceived. As a consequence, the deformed region may obtain the power to grow. Why, however, its velocity of growth is larger than that of the stimulating crystal is not yet clear. Perhaps the lattice of the stimulated crystal is more 'perfect' than that of the stimulating crystal. I have suggested[2], further, that a difference in the 'steepness' of the 'deformation gradient' between a growing nucleus and its undeformed surroundings may cause a difference in velocity of growth.

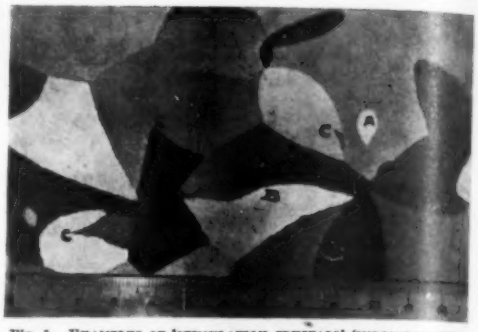

Fig. 1. Examples of 'stimulation crystals' (indicated with *C*). × ½. Reproduced from Sandee[1].

In this connexion it is of interest to reproduce in Fig. 2 a microphotograph (× 75), obtained by Gough Cox and Sopwith[3], which shows the boundary of a twin crystal in recrystallized aluminium, after subjection to alternating stresses. The twin plane is parallel to the visible glide lines. In the crystal on the left the twin plane coincided with the plane of maximal shear stress; this, however, was not the case in the crystal on the right. As therefore the

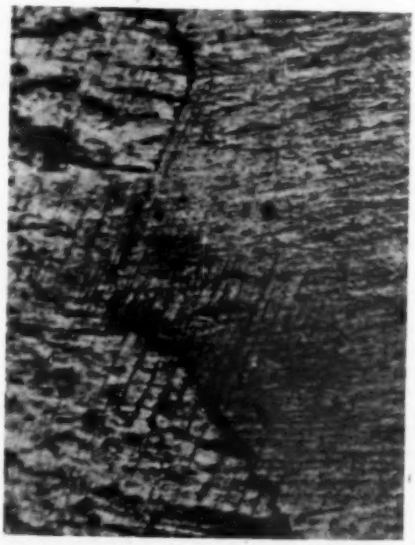

Fig. 2. Boundary of a twin-crystal in recrystallized aluminium after subjection to alternating stresses (microphotograph due to Gough, Cox and Sopwith). × 75.

appearance of the glide lines in the left one is quite normal, their continuation at the other side of the twin boundary in the right one must be considered as remarkable. On the view expressed above, their appearance might be conceived as caused by a process of gliding 'induced' in the right crystal by the glide process taking place in the left crystal (Gough *et al.* remark that the presence of a crack in the neighbourhood of the boundary may have influenced the distribution of stresses and in this way have caused the occurrence of gliding in the crystal to the right).

The possibility must be kept in mind that the process described by us as a stimulation does not exist in reality and is actually caused by an 'error' in the deposition of a layer of atoms along the octahedral plane, giving rise to the occurrence of the twin orientation. In that case it seems still more difficult to imagine in which way the experimentally observed difference in velocity of growth of the two parts of the twin comes into existence. Perhaps this second mechanism is the normal one for such metals as nickel, copper and nickel-iron, which twin frequently, producing twin lamellæ with straight boundaries.

Further particulars will appear in *Rec. trav. chim. Pays-Bas.*

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Laboratory for Physical Chemistry,
Technical University,
Delft. Aug. 22.

[1] Sandee, J., *Physica*, **9**, 741 (1942).
[2] Burgers, W. G., *Physica*, **9**, 987 (1942).
[3] *J. Inst. Metals*, **54**, 193 (1934).

New Ultra-Violet Band-Systems of SiS, SiSe and SiTe

The purpose of this note is to record new spectroscopic data for the molecules SiS, SiSe and SiTe. These are members of a group of twenty molecules formed from Group IV and Group VI elements, each of which (with the single exception of CTe) has been shown by earlier work[1] to give rise to at least one strong ultra-violet band-system, generally appearing readily in emission. Many of these systems have also been observed in absorption: it is convenient to call them $D-X$ systems. The existence of weaker $E-X$ systems, lying to shorter wave-lengths than the $D-X$ systems of GeS, SnO, SnS, SnSe and SnTe[1,2] suggested that other members of the group should possess similar E states.

We have examined the absorption of SiS, SiSe and SiTe vapour at temperatures of the order of 900°–1,000° C. in the ultra-violet region ($\lambda > 2050$ A.). The source was a hydrogen tube, and the spectra were photographed in a Hilger medium quartz instrument, a large Littrow spectrograph and in a first order of a 2·4 m. grating. For all three species the $D \rightleftarrows X$ and the expected $E \leftarrow X$ systems were observed. The former observation provides direct evidence that the $D \rightleftarrows X$ systems of these molecules all involve the ground-states. Vibrational analyses of the bands of the $E \leftarrow X$ systems have been carried out: the results are summarized in the following equations for the positions of the band-heads:

$$\text{SiS} \quad \nu\,(\text{head}) = 42720{\cdot}6 - [749{\cdot}5u'' - 2{\cdot}56u''^2]$$
$$+ [400{\cdot}7u' - 2{\cdot}31u'^2 - 0{\cdot}01u'^2]$$
$$\text{SiSe} \quad \nu\,(\text{head}) = 38505{\cdot}9 - [580{\cdot}0u'' - 1{\cdot}78u''^2]$$
$$+ [308{\cdot}8u' - 1{\cdot}95u'^2 - 0{\cdot}032u'^2]$$
$$\text{SiTe} \quad \nu\,(\text{head}) = 33991{\cdot}3 - [481{\cdot}2u'' - 1{\cdot}30u''^2]$$
$$+ [242{\cdot}0u' - 3{\cdot}63u'^2 + 0{\cdot}13u'^3],$$

where $u = v + \frac{1}{2}$.

In these equations, the expression for the ground-state vibrational levels of SiS has been taken from the analysis of the $D \rightleftarrows X$ system without modification: new measurements of bands of the $D \rightleftarrows X$ systems of SiSe and SiTe from the absorption plates have led to slight departures from the original values based on measurements of the systems as developed in emission.

The rather close analogy between the spectroscopic properties of isoelectronic molecules of this group previously noticed[1] is strengthened by the data for the new systems:

Number of extranuclear electrons = 48.

State		ν_e	ω_e	k_e		ν_e	ω_e	k_e
E	GeS	38890	310·4	1·27	SiSe	38506	308·8	1·16
D		32890	375·0	1·85		32449	403·4	1·99
X		0	575·8	4·36		0	580·0	4·11

Number of extranuclear electrons = 66.

State		ν_e	ω_e	k_e		ν_e	ω_e	k_e
E	SnS	33037	294·3	1·29	GeSe	35000	—	—
D		28338	331·9	1·64		30432	272·4	1·68
X		0	487·7	3·53		?0	406·8	3·75

State		ν_e	ω_e	k_e
E	SiTe	33991	242·0	0·79
D		28664	335·7	1·52
X		0	481·2	3·13

In this table, ν_e and ω_e are the electronic energy and the vibration frequency in cm.$^{-1}$, k_e is the force constant in dynes/cm. $\times 10^{-5}$. These results make it appear likely that the weak bands observed in the emission spectrum of GeSe at shorter wave-lengths than the main system[3] are in fact part of a poorly developed $E \rightarrow X$ system ($\nu_e \sim 35{,}000$ cm.$^{-1}$) analogous to those of SnS and SiTe.

The corresponding systems for the lighter members of this group would be expected to lie in the vacuum ultra-violet region, and are thus outside the scope of the present investigation. The absorption spectra of some of the heavier members have recently been examined in the ultra-violet region, and systems apparently involving yet higher excitation than E levels have been found. The results of this work will be published in due course.

E. E. Vago.
R. F. Barrow.

Physical Chemistry Laboratory,
Oxford. Aug. 21.

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[2] Barrow, R. F., and Vago, E. E., *Proc. Phys. Soc.*, **56**, 78 (1944).
[3] Barrow, R. F., and Jevons, W., *Proc. Phys. Soc.*, **52**, 534 (1940).

Influence of Different Synthetic Œstrogenic Compounds on the Egg-Laying Capacity and the Growth of Poultry

In earlier experiments[1] the influence of the synthetic œstrogenic compound triphenylethylene on the growth and egg-laying capacity of poultry was investigated. It was found that hens treated with this synthetic product were slightly heavier in weight than the untreated birds. The difference in weight was more striking in female turkeys, where the percentage increase in weight was 311·48 in the case of those taking triphenylethylene, compared with 244·65 in the control group. The compound was found to have no beneficial effect on the egg-laying of female turkeys.

A new experiment has been carried out to examine the effect of different synthetic œstrogenic compounds on the growth and egg-laying capacity of hens. The compounds tested were stilbene[2] (symmetrical diphenylethylene), triphenylethylene[3,4], triphenyl-

chloroethylene[5] and stilbœstrol[6] (4.4'-dihydroxy-β-diethylstilbene). Stilbene and triphenylethylene are weakly active œstrogenic compounds.

Five groups of 26 hens, each group consisting of 10 Fayoumi and 16 Baladi (Egyptian races), were used. The average age of the hens at the start of the experiment was 101 days. The compounds were given with the morning ration three times a week, on Saturdays, Mondays and Wednesdays, during April 17–June 18, 1943 (63 days); in the case of stilbene, the period was April 17–May 25, 1943 (38 days). The basic ration for all groups consisted of: maize and barley, 55; beans, 5; rice bran, 25; cotton-seed cake, 15; common salt, 0·5 per cent. In addition, 20 c.c. of sour skim milk was added. The starch equivalent of this ration was 72·25 per cent, and the digestive proteins were 10·15 per cent. The amount of ration given daily per hen was successively as follows: 50 gm. for one period (28 days), 60 gm. for five periods (140 days), 70 gm. for two periods (56 days), 80 gm. for five periods (140 days) and 90 gm. for five periods (140 days). The animals were weighed once every period of 28 days. In addition, green foliage (barsim clover—*Trifolium Alexandrinum*—during winter and green maize during summer) varying from 50 to 100 gm. a hen was given throughout the whole experiment.

The period (in days) of application of the drug was: stilbene group 38, triphenylchloroethylene group 63, stilbœstrol group 63, triphenylethylene group 63. The dosage (in grams) for each hen for the above groups was: 0·0500, 0·0012, 0·0012, 0·0250 and the total amount (in grams) for each hen was: 0·8500, 0·0324, 0·0324, 0·6750. The average weight of the hen (in grams) at the start of the experiment on April 12, 1943, was for the four groups: 435, 427, 440, 428, and at the end of the experiment (May 27, 1944) 1,277, 1,253, 1,164, 1,316. For the control group the figures are 426 and 1,252.

The result obtained with triphenylethylene was similar to that in our experiment already summarized above. With stilbœstrol and triphenylchloroethylene, there was no improvement as regards weight or egg-laying capacity. With stilbene, however, a marked effect on egg-laying capacity was noticed; but no beneficial effect whatsoever on growth.

From the table, it can be seen that the hens receiving stilbene began to lay eggs more than a month earlier than the control group; 0·8500 gm. of stilbene given per hen during 38 days produced 24 eggs more than the control hen throughout the whole period of the experiment (13 months). This result is not only important from the theoretical point of view, but also has an economic value, if it is desirable to have birds which lay eggs early.

We propose the term 'præcopubic compounds' from the Latin *præcoque* = over hastily) for stilbene and for substances producing a similar biological action. Perhaps this action of stilbene may be of value in mammals for cases of abnormal retarded puberty.

We have also observed that stilbœstrol and triphenylchloroethylene have an inhibitory effect on the growth of the combs of cockerels, so that the combs atrophied after the administration of 0·0180 gm. of either compound. The effect was more pronounced with stilbœstrol than with triphenylchloroethylene. The combs regained their normal size and appearance some time after the addition of the compound had been discontinued.

Our thanks are due to Dr. M. Elkateb, who assisted in this investigation.

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Aug. 8.

EFFECT OF ŒSTROGENIC COMPOUNDS ON THE EGG-LAYING POWER OF HENS.

	Stilbene group	Triphenyl-chloro-ethylene group	Stilb-œstrol group	Triphenyl-ethylene group	Control
Age of hens when laying starts	114 days	131 days	162 days	179 days	146 days
Total number of eggs laid per hen up to May 31, 1944	132·4	111·0	112·7	95·1	108·1
Average number of eggs per hen per month	10·18	8·53	8·67	7·31	8·32
Average weight of eggs (gm.)	38·43	39·24	39·35	39·82	40·22
Average total wt. of eggs per hen per month	391·4	334·8	341·1	291·3	334·3
Average total wt. of eggs compared with 100 control	117	100	102	87	100

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[6] Dodds, E. C., and Lawson, W., *Nature*, **139**, 627 (1937).
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[8] Dodds, E. C., Fitzgerald, M. E. H., and Lawson, W., *Nature*, **140**, 772 (1937).
[9] Robson, J. M., Schönberg, A., and Fahim, H., *Nature*, **142**, 292 (1938).
[10] Dodds, E. C., Goldberg, L., Lawson, W., and Robinson, R., *Nature*, **141**, 247 (1938).

Production of Capons by the Use of Synthetic Œstrogens

IN view of the ready availability and cheapness of synthetic œstrogens, it was considered that there existed a real possibility of production of capons, or of partially neutered table poultry, with many of the desirable attributes of capons, by the use of stilbœstrol without any of the disadvantages (operative mortality and growth set-backs, skilled labour expenses, etc.) attendant upon normal capon production. Work upon this subject in the United States[1,2] has largely centred upon subcutaneous implantation of pellets of synthetic œstrogen (stilbœstrol), but success has also attended the use of diethylstilbœstrol dimethyl ether *per os*[3,4]. The use of stilbœstrol in quantities up to 23 mgm./lb. of feed was stated[3] to be insufficient for practical use in fattening.

In 1943 we initiated experiments on the feeding of stilbœstrol to fattening cockerels, the œstrogen being used at the rate of 4 mgm./lb. of mash. Results of these trials (which will be reported in detail elsewhere) indicate a statistically significant and economically worth-while increase in the rate of growth as between treated and control groups of birds, food consumption of the two groups being identical. It

appears therefore that better utilization of food (possibly due to a lowered metabolic rate) can be attained by the oral use of stilbœstrol on fattening cockerels. Our findings are therefore contrary in this respect to those of Jaap and Thayer[3]. It was further noticeable in our œstrogen-fed birds that carcase quality was improved over controls in the respects outlined by Lorenz[2].

The possibility suggested by Jaap and Thayer[3] that other synthetic œstrogens may be more active orally, weight for weight, than stilbœstrol for poultry, however, is not ruled out and is being explored.

D. G. S. Black.

The University, Reading.

R. Gordon Booth.

Cereals Research Station,
(Ministry of Food), St. Albans.
Sept. 10.

[1] Lorenz, F. W., *Poultry Sci.*, **22**, 190 (1943).
[2] Lorenz, F. W., *Poultry Sci.*, **24**, 128 (1945).
[3] Jaap, R. G., and Thayer, R. H., *Poultry Sci.*, **23**, 249 (1944).
Thayer, R. H., Jaap, R., and Penquite, R., *Poultry Sci.*, **23**, 555 (1944).

Fructose, a Constituent of Semen

Bull spermatozoa separated by centrifugation and washing from the seminal plasma can survive anærobically only if some glycolysable carbohydrate is added[1]; they can utilize glucose, fructose and mannose but not glycogen. In the whole semen, on the other hand, the spermatozoa survive without any additional sugar and they live at the expense of a reducing carbohydrate already present in the seminal plasma. Hitherto, this carbohydrate has been regarded as glucose[2]. However, in view of the inadequate evidence as to the identity of the sugar, an investigation of its chemical nature was undertaken. It revealed that the greatest part of the reducing sugar content of the seminal plasma is derived not from glucose but from fructose. From 120 ml. of bull semen, on purification, 15 ml. of a solution were obtained in which both the optical activity and the reducing value were determined and found to correspond to 630 mgm. fructose. Fructose was also identified as crystalline methylphenyl-fructosazone[3]. In small samples of semen (0·1 ml.) it was found possible to estimate fructose quantitatively by an adaptation of the method of Roe[4]; the analysis of seven freshly collected samples of bull semen gave the following results.

Reducing sugar, mgm. per cent	785	635	498	447	1090	531	1698
Fructose, mgm. per cent	779	592	480	376	1040	453	1062

On standing, the amount of fructose in the whole semen falls progressively and lactic acid is formed as the result of fructolysis.

Hitherto, with the exception of embryonic liquids and of certain metabolic dysfunctions like fructosuria[5,6], there was but scanty evidence for the occurrence of free fructose in the animal body, and frequently the claims were based merely on the non-specific colour reactions. The identification of fructose in the seminal plasma by lævorotation and by the isolation of the methylphenylfructosazone establishes this sugar as a natural constituent of an important body fluid.

This work has been carried out on behalf of the Agricultural Research Council. The collection of the material was made possible by the co-operation of Dr. A. Walton and of the following veterinary officers in charge of the Insemination Centres in England: Mr. R. Clarke, Mr. E. Conn, Mr. L. E. A. Rowson, Mr. G. Smith and Mr. D. L. Stewart.

T. Mann.

Molteno Institute,
University, Cambridge.
Oct. 27.

[1] Mann, T., *Nature*, **156**, 80 (1945).
[2] For references see Salisbury, G. W., and Vandemark, N. L., *Amer. J. Physiol.*, **143**, 692 (1945).
[3] Neuberg, C., and Strauss, H., *Z. physiol. Chem.*, **36**, 227 (1902); *Biochem. Z.*, **4**, 292 (1907).
[4] Roe, J. H., *J. Biol. Chem.*, **107**, 15 (1934).
[5] Orr, A. P., *Biochem. J.*, **18**, 171 (1924).
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Scientific Affairs in Europe

In view of Dr. Buzzati-Traverso's letter[1] passed on by Prof. Julian Huxley, it may be of interest to put on record that I was, so far as I know, the first Allied man of science to make contact with the University of Padua at the close of the campaign in northern Italy this spring. The eagerness with which the few recent copies of *Nature* I happened to have with me were received and devoured by the scientific staff impressed on me, more than anything I had previously experienced, the complete isolation of Italian scientific workers.

The scientific departments at Padua are well equipped by comparison with Milan, where local interest in the welfare of the University is, as might be expected, much less than at Padua, which is naturally proud of its great traditions as a university town. Consequently, Padua has been, even during the War, a more favourable environment for research than might have been expected—witness the recent letter in *Nature* by Prof. d'Ancona[2]. Though bombed seriously on occasions and temporarily closed during the final weeks of the campaign (some members of the staff and many of the students took an active part in the partisan movement) the University did not, like Bologna, suffer from a prolonged paralysis.

I would like to re-emphasize Dr. Buzzati-Traverso's statement that the most urgent need of Italian scientific men (and this must apply also to other parts of Europe) is "to become acquainted with the scientific production of the Allied Nations during the last five years". The distribution of current numbers of *Nature* and of the more specialized reviewing and abstracting journals is essential, but is only part of the answer; and it will presumably be several years before libraries, even when undamaged, can be made "comprehensive and up-to-date". The most desirable, practicable and rapid method of rehabilitating the Continental research worker (so far as information is concerned) is surely to put him into personal contact with an Allied man of science working in the same field, or with the appropriate learned society which could refer him to a suitable specialist. In this way he could most easily obtain information on recent developments and copies of original publications in his special subject. Such contacts can be established immediately, and more could be done to encourage and facilitate them. Other aspects of international scientific co-operation will require at least some time for effective organization.

L. C. Beadle.

Department of Zoology, King's College,
University of Durham, Newcastle-on-Tyne.
Nov. 20.

[1] *Nature*, **156**, 576 (1945).
[2] *Nature*, **156**, 603 (1945).

INVESTIGATION OF INSECTICIDAL SPRAYS

By Dr. A. B. P. PAGE, A. STRINGER and R. E. BLACKITH

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THE toxicity of oil-base sprays to flying insects can readily be determined if care be taken to standardize the conditions. Preliminary experiments with emulsion sprays confirmed an impression derived from conflicting reports of other workers that the toxicity of these sprays is more difficult to determine. It also suggested to us that other measurements than those of particle-size and toxicity would be necessary if progress were to be made in the making up and application of these emulsion sprays.

The overall toxicity of a spray to a particular insect depends on many factors. The chemical and physical composition of the spray liquid can readily be controlled; but the number and size of the drops which adhere to an insect depend not only on the variable properties of the spray itself, and the experimental spraying facies, but also on the structure and bio-responses of the particular insect; for example, its susceptibility to paralysis or to irritation, the surface structure of the wings, and the product of their surface area and velocity at the centre of pressure, which depends on both wing beat and wing form.

Several workers[1,2,3,4,5] have made measurements of particle-size distribution and have demonstrated how this and the activity of the flying insects affect the amount of spray picked up.

Determinations of pick-up from oil-base sprays have been made by David[3] using an organic dyestuff afterwards washed from the insect. We have devised a chemical method of investigation applicable to straight aqueous sprays and emulsions which depends on the inclusion in the spray of aluminium chloride, which, except in high concentration, has no irritant or toxic effect on the sensitive *Aedes ægypti* mosquitoes. After treatment, the insects are collected and subjected to complete low-temperature oxidation to eliminate errors due to the absorption of tracer, such as are known to occur with dyestuffs.

The residual aluminium is then determined colorimetrically by means of the blue lake formed in a buffered solution with hæmatoxylin. The overall reproducibility, using 50–100 adult *Aedes ægypti* mosquitoes, is ± 3 per cent, and as little as 0·002 mgm. aluminium can be determined in a final volume of 40 ml. of reagents. This method has proved particularly suitable for the study of the relationship between pick-up of spray by the insect, and with it the toxic agent, and spray dosage in ml. of spray liquid per unit volume of air space, and also that between pick-up and the concentration of toxic agent in the spray liquid.

The results obtained with pyrethrins as activating agents against *Aedes ægypti* L. have led us to the conception of a pair of average threshold values of the amount of pyrethrins picked up by the insect which control its responses. The lower value governs the transition from normal to stimulated flight activity. It is about $0{\cdot}12 \times 10^{-7}$ mgm. of pyrethrins, equivalent to about 0·025 mgm. per kgm. body-weight, and is independent of the spray dosage. The second or 'knockdown' threshold, corresponding to a pick-up of $6{\cdot}0 \times 10^{-7}$ mgm. pyrethrins per insect or about 1·25 mgm./kgm. body weight, shows itself biologically as a sudden rapid increase in the rate of knockdown action with increase of pyrethrins concentration in the spray, but is more evident as a sharp peak, in the spray pick-up – pyrethrum concentration curve, which varies with the spray dosage in such a way that the corresponding pyrethrum pick-up remains constant, just as the 'activation' threshold is independent of spray dosage.

This theoretical relationship appears to break down when the spray dosage rises above 194 ml. per 100 cu. m. (55 ml. per 1,000 cu. ft.), when the spray pick-up rises more rapidly than the controlling threshold value would predict. This point is well borne out by considering the efficiency of the spray, expressed as the ratio effective dosage/nominal dosage, and calculated from values corresponding to selected points on the spray pick-up toxicant concentration curve.

The efficiency ratio at peak activation, that is, at the 'knockdown' threshold pyrethrins concentration for various spray dosages, decreases rapidly from 10 to 35 ml. per 100 cu. m. (3–10 ml. per 1,000 cu. ft.), and should not rise again if control by the 'knockdown' threshold pick-up were still valid until a spray dosage of about 250 ml. per 100 cu. m. (70 ml. per 1,000 cu. ft.) had been attained. In practice, however, a sharp rise occurs in the region of 190–210 ml. per 100 cu. m. (55–60 ml. per 1,000 cu. ft.) supporting the view that the 'knockdown' threshold pick-up begins to rise with the spray dosage in this region.

Preliminary investigation of the curves for *Musca*

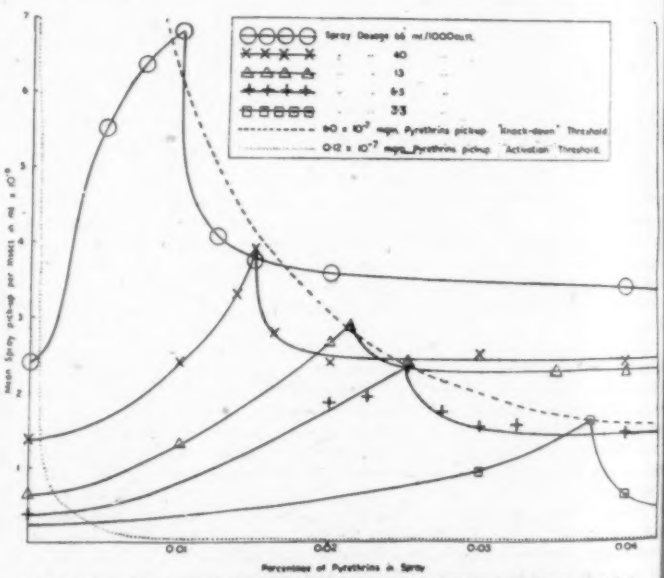

Fig. 1. VARIATION OF SPRAY PICK-UP BY *Aedes ægypti*: AQUEOUS EMULSION AT 30° C. AND 100 PER CENT R.H.

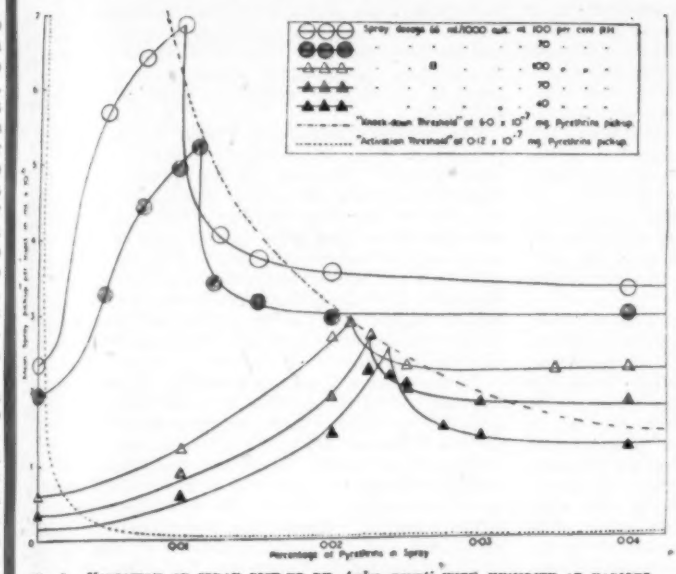

Fig. 2. VARIATION OF SPRAY PICK-UP BY *Aedes ægypti* WITH HUMIDITY AT VARIOUS SPRAY DOSAGES.

domestica L., *Culex pipiens* L., *Coccinella septempunctata* L., *Vespula vulgans* L., and *V. germanica* Fabr., queens and workers, and *Rhagonycha fulva* Scop., confirms the existence of both threshold values for these insects also.

These considerations have a special bearing on the methods of bio-assay of insecticides with flying insects, and raise again the questions of standardizing the activity of the insects[4] and the standardization of the 'mean free flight' of the insect; and they support the views expressed by C. A. Murray[6] on the subjects of dosage measurement and pick-up distribution in Peet-Grady testing. Our method of investigating insect responses in toxic sprays opens up a new line of attack on the form of the dosage – mortality curve.

An important result of the investigation is to suggest that neither the amount of spray liquid nor the amount of toxic agent received by the insect can any longer be considered to be proportional to the spray dosage if an irritant substance is present in the spray and is approximately proportional to the toxicant concentration only over a limited range. It may prove possible to relate the changes of response evident in the spray pick-up – toxicant concentration curves with the deviations shown at high and low mortalities from the conventionally sigmoid dosage – mortality curve.

We have also investigated the rate of pick-up of sprays containing various concentrations of pyrethrins on *Aedes ægypti*, and find that for these mosquitoes the 10-minute exposure period for spray is the most suitable, at least for water-base sprays.

Experiments designed to examine the influence of reducing the humidity in the spray chamber show that the overriding physical effect, for water-base sprays, is to reduce the effective dosage/nominal dosage ratio. Any biological effects which may occur are not evident under our experimental conditions, which have not, as yet, included any lengthy conditioning period at the altered humidity.

The analytical method which has been described may be applicable under conditions which rule out biological investigation. For example, the flight-stimulating action of pyrethrins can be estimated biologically up to a certain concentration of poison per cubic foot by including D.D.T. in the spray and observing the resultant lethal effect; but above this concentration this biological method fails because too high a kill is obtained. There is no such limitation to the use of the chemical method.

It is hoped to extend this work to cover the responses of a series of insects of varying structural characteristics, to examine the action of other insecticidal and irritant compounds both in aqueous and in oil sprays and to combine the methods of determination with other observations on the deposition and action of insecticidal films.

We are indebted to the Chief Scientific Officer, Ministry of Supply, for permission to publish this work.

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[6] Page, A. B. P., Stringer, A., and Blackith, R. E., Insecticides Development Panel, Ministry of Production, (45), 232 (unpublished).
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SCIENTIFIC RESEARCH IN AUSTRALIA AND NEW ZEALAND

THE second discussion on the organisation of science in the British Commonwealth arranged by the Society for Visiting Scientists was held at the Society's House at 5 Old Burlington Street, London, W.1, on December 19. Prof. M. L. E. Oliphant presided, and the speakers included Dr. J. C. Andrews, member of council of the New Zealand Department of Scientific and Industrial Research; Dr. F. P. Bowden, head of the Research Group on the Physics and Chemistry of Rubbing Solids, University Chemical Laboratory, Cambridge; Mr. G. B. Gresford, head of the Australian Research Liaison Office, Australia House, London; Dr. C. H. Kellaway, director of the Wellcome Research Institution; Prof. Eric Ashby, recently scientific attaché to the Australian Legation in the U.S.S.R.; Mr. Edgar Booth, chairman of the Institute of Wool Secretariat; Dr. E. H. S. Burhop, lecturer in the Department of Applied Physics, University College, London; Dr. Julian Huxley; and Mr. H. E. Wimperis, scientific adviser to the Australian Government.

In Australia and New Zealand, physical, ecological, historical and political factors influence both the nature of the scientific problems to be solved and the conditions for their solutions. Australia is in general arid, with two thirds of its area semi-desert, but with

tropical conditions in the north ; it is relatively poor in natural resources. Owing to its long geological isolation, it is rich in primitive and interesting forms of life, but these are rapidly disappearing, and introduced species often become pests. Until the War, Australia was largely dependent on agriculture, notably wheat and wool ; but the War has necessitated the development of secondary industries, such as aircraft bearings and 'jelled' petrol, both of which were successfully developed by teams of research workers, largely young Australian graduates. The wool industry has also found it necessary to finance research in order to compete with the progress of synthetic fibre, which causes considerable anxiety.

Politically, Australia is a federation with seven parliaments and governments of the six States and of the Commonwealth. This raises problems in research ; for example, in forestry and some other fields, the Commonwealth has to obtain the permission of the States for the authorization of research grants.

Historically, Australian ties have been almost wholly with Britain, on which she relied for scientific ideas and as a training ground for advanced students ; but during the War Australian science has been forced to depend more on its own resources, while at the same time making new contacts with the United States. The main body concerned with research is the Council for Scientific and Industrial Research, which operates free from departmental control or Government interference, largely owing to the personality of Sir David Rivett. In addition, Government research is done by the Munitions Supply Laboratories, the Commonwealth Observatory, the Department of Agriculture and Mines, the National Health and Medical Research Council, and other bodies. The last-named Council is largely concerned with public health services, and there is a good deal of backing for the establishment of a body more purely concerned with medical research, such as the Medical Research Council in Britain.

Recently, it has been announced that a Commonwealth Experimental Station is to be set up in the sparsely populated area of Central Australia for research on guided missiles and pilotless aircraft that will be needed for tests on flight at speeds near that of sound.

For biology and medicine there are several research institutes of high standard. Both at Brisbane and in Queensland, research on the effects of tropical conditions, and on tropical diseases, is being carried out. In Sydney there are two institutes of medical research, in one of which interesting work on acoustics is proceeding. There is also the University Medical School, which includes an R.A.F. research station : this links up with the valuable research of the Physics Department on the effects of gravity and on anti-gravity measures. In Adelaide there exists an institute which is unique in combining research on human and animal diseases.

Nearly every speaker stressed the fact that university research suffers from the heavy teaching duties of the staff. It is not so much the high ratio of students to staff as the too great number of different courses which one man is required to give, and the undue size of first- and second-year classes. The present tendency towards entering universities at a low age (the average is now only just over seventeen) should be reversed ; the standard and ceiling of school teaching should be raised, and more use made of junior technical schools. At the moment, no university gives a higher research degree such as Ph.D. The institution of such degrees should materially increase the number of research students ; in addition, something should be done to guarantee posts to those who do well in their post-graduate research.

The present tendency had been to lose an undue proportion of scientific talent : many graduates who have gone to England for post-graduate work or research have not returned to Australia. To obviate this, and to make the best use of the Empire's scientific man-power and of its various fields of research, a comprehensive scheme is needed. This should include provision for senior workers from Britain to visit Australia and other Dominions for periods of one to several years, and for young British graduates to begin their research careers in the Dominions without thereby reducing their chances of return later.

In the opinion of several speakers, Australia should concentrate on those fields of research in which she naturally provides special opportunities : this would attract workers from other countries. Further, cheaper and easier travel for teaching staff and research workers is essential if intellectual isolation is to be avoided. It would be desirable to establish some common organisation for Dominion higher education and research, analogous to the Colonial Higher Education Committee. Within Australia there is need for some scientific public relations organisation to explain the value and interest of science to the public.

Scientific workers in New Zealand suffer likewise from isolation and the lack of contacts with colleagues in the same or related fields, and the public is also far from appreciating the value of scientific research, although the War had an enlivening effect in this direction. Most scientific work comes under the governmental Department of Scientific and Industrial Research, established in 1926. Most of its work is concerned with agriculture, as New Zealand is almost entirely dependent on agricultural produce. It also has physical and chemical laboratories and meteorological stations. Some of the major problems are those of soil erosion, the economic use of fertilizers, animal improvement, standardization, and questions connected with high rainfall, rivers and forestry.

The University of New Zealand consists of six university colleges, of which two are agricultural. Research opportunities and activities are not so great as could be wished. An interesting scheme has just been set up by the Research Council of the Department of Scientific and Industrial Research, whereby generous fellowships are made available to graduates, on condition that they bind themselves to work in New Zealand for a minimum number of years after the end of their training. It is hoped thus to prevent the leakage of good workers to Britain and other countries.

Dr. Andrews also stressed the need for the over-all co-ordination of Empire research. His views on this form a fitting conclusion to the account of this interesting meeting. He is firmly convinced that by full co-operation between the various Dominions and Colonies, including the setting-up of well-equipped scientific institutes in the regions most suitable for particular lines of research, a much fuller flow of scientific talent would be maintained in both directions between Britain and other territories, and that not only the individual Dominions and Colonies would benefit markedly, but also Britain and the Empire as a whole.

RADIO COMMUNICATION DEVELOPMENTS

At the inaugural meeting on October 10 of the Radio Section of the Institution of Electrical Engineers, the chairman for the present session, Mr. A. H. Mumford, gave an address in which he reviewed some of the more general communication developments carried out by the Post Office Engineering Department during the past few years. These developments covered three main fields: first, the extension and improvement of the facilities for world-wide telegraphic communication on a low frequency; secondly, the study and improvement of long-distance high-frequency telephone and telegraph circuits; and thirdly, the extension of very-high frequency radio links for multi-channel communication over short distances.

Shortly after the occupation of western Europe in 1940, plans were made for setting up a new station operating on a very-low frequency to act as reserve in case of damage to the telegraph transmitter at Rugby, which has been in operation for some twenty years on a frequency of 16 kc./s. The new station was built on a plain in the west of England, and the aerial is supported by three 600-ft. self-supporting towers on one side, while on the other the aerial triatics are anchored to the top of a hill some 800 ft. high, and with a steeply sloping side to the plain below. The aerial tuning-coil is similar in design to that used in the original Rugby station; it comprises five hexagonal coils, nearly 16 ft. in diameter, wound on a framework of American whitewood, the overall diameter of the "litzendraht wire" used being about 1·5 in. The aerial and intermediate circuit inductors are housed in a room the walls and roof of which contain a certain amount of steel reinforcement. By suitably screening the room with copper wire, the losses due to the presence of the steel were decreased considerably, with a resulting improvement in the overall efficiency of the station.

During March 1943, the original radio station at Rugby was seriously damaged by fire, and the main aerial tuning coil was destroyed. Although the reserve transmitter referred to above was nearly completed, it was still deemed essential to restore the original station to working order. Lack of the appropriate materials precluded the reconstruction of the coil to the original design, and accordingly an outdoor aerial tuning coil was designed and constructed. This external coil is of a helical hexagon shape, of maximum diameter 65 ft., and is wound with ten turns of a cage of copper wires. The coil is supported by poles 67 ft. high erected in a circle of more than 100 ft. in diameter. A model of this coil and also of the aerial system at the new station were displayed at the meeting.

Mr. Mumford next referred to some of the difficulties which are encountered in the transmission of high-frequency radio waves (for example, 20 Mc./s.) over a path such as that between New York and London, due to selective fading caused by different frequency components of the signal having traversed paths of appreciably different length. A demonstration was given of some laboratory equipment which simulated the transmission of radio waves over three paths of different attenuation and time delay; by suitably adjusting the characteristics of the three paths, interference and fading phenomena can be reproduced and studied.

With this equipment, it was shown that the distortion of the signal in double side-band transmission due to the selective fading of the carrier wave relative to the side-bands can be appreciably reduced by the use of single side-band technique. Such an improvement has been borne out in practice, and the laboratory equipment using an artificial propagation medium enables the radio engineer to obtain quantitative results which can be immediately applied by the receiver designer. The same equipment can be used to investigate the effectiveness of diversity reception in reducing the distortion of signals, and the extent to which the aerial spacing is critical in such reception.

For the reception of signals from a station in New Jersey, U.S.A., on five frequencies between 5 and 20 Mc./s., the multiple-unit steerable antenna ('musa') system installed by the Post Office at Cooling, Kent, has been in commercial operation since July 1942. This system comprises sixteen rhombic antennæ spaced at regular intervals over a distance of two miles along the great circle towards the transmitting station at New Jersey. By combining the signals from the individual antennæ with suitable phase shift, the major lobe for reception can be varied in the vertical plane. The system is equipped and calibrated to measure the arrival angles, relative to the ground, of the components of the incoming signal, and their field strengths. Such measurements of field strength and wave angle are made day by day at hourly and quarter-hourly intervals respectively, and the results of the measurements, which are available from July 1942 to the present time, provide data of particular interest to the ionospheric physicist and to the radio engineer. During the address, the signals from America received at the 'musa' station at Cooling were relayed to the Institution and displayed on cathode ray oscilloscopes set up in the lecture theatre.

During the past eight years multi-channel radio links operating on the very-high frequencies between 40 and 100 Mc./s. have been developed to form part of the main trunk telephone network to bridge gaps over river estuaries or between islands and the mainland. These links carry twelve speech circuits occupying the frequency band 12–60 kc./s., which can be conveniently transmitted over a coaxial cable upon which modern trunk communications are based. This development is in fact indicative of the merging of line and radio techniques which is so essential to the effective exploitation of the communication art on both a national and international basis. The earlier installations of this twelve-channel radio link used transmitter powers of 100 watts and amplitude modulation; and the sending and receiving equipment was installed in one building which is normally left unattended. More recently, a comprehensive series of field tests has shown that by using frequency modulation, a number of technical limitations could be overcome and the same grade of service could be provided with a transmitter power of 10 watts. This reduction in power is of vital importance to the unattended operation aspect, since both power supply requirements and bulk of equipment are appreciably reduced.

Later experiments have shown that it is quite practicable to have very-high frequency radio links operating on frequency modulation technique and carrying sixty speech circuits simultaneously, thus allowing an even more complete merging of line and radio techniques.

FORTHCOMING EVENTS

Monday, January 21

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Dr. S. G. Hooker: "High Speed Flight" (Cantor Lectures, 1).

Tuesday, January 22

SHEFFIELD METALLURGICAL ASSOCIATION (at 198 West Street, Sheffield 1).—Annual General Meeting.

SOCIETY OF CHEMICAL INDUSTRY, AGRICULTURE GROUP (in the Physics Lecture Theatre, Royal College of Science, Imperial Institute Road, London, S.W.7), at 2.30 p.m.—"Innovations in Plant Feeding Methods". Prof. R. H. Stoughton: "Methods for the Direct Nutrition of Plants"; Dr. W. G. Templeman: "Sand Culture—Automatic Surface Application of Nutrients"; Mr. C. R. Thompson: "Correcting Deficiencies in Fruit Trees by Inserting Nutrient Tablets".

ROYAL PHOTOGRAPHIC SOCIETY, SCIENTIFIC AND TECHNICAL GROUP (at 16 Princes Gate, London, S.W.7), at 6 p.m.—Prof. L. C. Martin: "Physical Study of Optical Images" (Thirty-eighth Traill-Taylor Memorial Lecture).

SOCIETY OF INSTRUMENT TECHNOLOGY (at the London School of Tropical Medicine, Keppel Street, London, W.C.1), at 7 p.m.—Mr. B. G. Higgins: "Electronic Controls for Resistance Welders".

Wednesday, January 23

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Mr. S. J. Wright: "Recent Developments in Agricultural Machinery".

INSTITUTE OF PHYSICS, INDUSTRIAL SPECTROSCOPIC GROUP (at the Royal Institution, Albemarle Street, London, W.1), at 3 p.m.—Inaugural Meeting. Lieut.-Comdr. J. Convey: "The History and Present Status of Emission Spectroscopy as Applied in Industry".

ROYAL STATISTICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Dr. F. Yates: "A Review of Recent Statistical Developments in Sampling and Sampling Surveys".

SOCIETY FOR VISITING SCIENTISTS (at 5 Old Burlington Street, London, W.1), at 7.30 p.m.—Discussion on "Science in Great Britain" (Speakers: Sir Edward Appleton, K.C.B., F.R.S., Mr. J. G. Fryer and Sir Edward Mellanby, K.C.B., F.R.S.).

Thursday, January 24

ASSOCIATION FOR SCIENTIFIC PHOTOGRAPHY, MEDICAL GROUP (at Hastings Hall, B.M.A. House, Tavistock Square, London, W.C.1), at 6 p.m.—Discussion on "Medical Photographer, or Photographing Medico".

CHEMICAL SOCIETY (joint meeting with the LOCAL SECTION of the ROYAL INSTITUTE OF CHEMISTRY, in the Chemistry Lecture Theatre, The University, Manchester), at 6 p.m.—Dr. W. A. Waters: "Some Recent Developments in the Chemistry of Free Radicals" (Tilden Lecture).

INSTITUTION OF ELECTRICAL ENGINEERS (joint meeting (partly by radio link) with the INSTITUTE OF RADIO ENGINEERS OF AMERICA, at Savoy Place, Victoria Embankment, London, W.C.2), at 6.45 p.m.—Mr. J. A. Pierce: "An Introduction to Hyperbolic Navigation".

Friday, January 25

PHYSICAL SOCIETY, OPTICAL GROUP (in the Lecture Theatre of the Science Museum, Exhibition Road, London, S.W.7), at 3 p.m.—Scientific Papers.

CHEMICAL SOCIETY (in the Chemistry Department, University College, Dundee), at 5 p.m.—Dr. E. G. V. Percival: "Chemical Products from Seaweeds".

INSTITUTION OF ELECTRICAL ENGINEERS, MEASUREMENTS SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "Instruments for Special Purposes" (to be opened by Mr. R. W. Griffin).

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Mr. G. O. Watson: "Recent Developments in Alternating-Current Turbo-Electric Ship Propulsion" (Eighteenth Thomas Lowe Gray Lecture).

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (in the Lecture Theatre of the Mining Institute, Newcastle-upon-Tyne), at 6 p.m.—Mr. R. E. Zoller: "Developments in Marine Water-tube Boiler Design".

BRITISH ASSOCIATION OF CHEMISTS, NOTTS. AND DERBY SECTION (in Room 104, Technical College, Leicester), at 7 p.m.—Mr. S. H. Wilkes: "Protection against Industrial Poisons".

INSTITUTE OF PHYSICS, MANCHESTER AND DISTRICT BRANCH (in the Large Physics Theatre, The University, Oxford Road, Manchester), at 7 p.m.—Dr. J. H. Chesters: "The Physical Properties of Ceramics".

SOCIETY OF DYERS AND COLOURISTS, SCOTTISH SECTION (at St. Enoch Hotel, Glasgow), at 7 p.m.—Mr. F. L. Goodall, Mr. J. V. Summersgill and Mr. T. F. Gorton: "D.D.T. and its Textile Applications".

BRITISH ASSOCIATION OF CHEMISTS, ST. HELENS SECTION (at the Y.M.C.A. Buildings, St. Helens), at 7.30 p.m.—Mr. C. Jones: "Chemistry of Clays".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT LECTURER IN PREPARING, COMBING AND SPINNING, in the Bradford Technical College—The Director of Education, Town Hall, Bradford (January 26).

DEPUTY BOROUGH ELECTRICAL ENGINEER AND MANAGER—The Borough Electrical Engineer and Manager, Heston and Isleworth Electricity Department, 11 Staines Road, Hounslow (January 26).

LECTURER IN THE MINING DEPARTMENT—The Principal, Technical College, Church Street, Barnsley (January 26).

ASSISTANT MASTER to take CHEMISTRY and PHYSICS—The Principal, Enfield Technical College, Queensway, Enfield, Middx. (January 26).

SENIOR ASSISTANT IN THE DEPARTMENT OF MECHANICAL AND AUTOMOBILE ENGINEERING in the Doncaster Technical College—The Chief Education Officer, Education Offices, Wood Street, Doncaster (January 28).

JUNIOR ASSISTANT PHYSICIST for routine and development work in the Physics Department—The Director, Radiotherapy Centre, Memorial Hospital, Scunthorpe, Lincs. (January 29).

EXAMINING OFFICERS (temporary) at H.M. Patent Office, London—The Ministry of Labour and National Service, Appointments Department, Technical and Scientific Register, Room 572, York House, Kingsway, London, W.C.2, quoting P.O./572 (January 31).

DEPUTY ENGINEER AND MANAGER OF THE WINCHESTER ELECTRICITY DEPARTMENT—The Town Clerk, Guildhall, Winchester, endorsed 'Deputy Electrical Engineer and Manager' (January 31).

ASSISTANT REGISTRAR—The Principal and Clerk to the Governing Body, Wigan and District Mining and Technical College, Wigan (January 31).

LECTURER IN PSYCHOLOGY at Rhodes University College, Grahamstown, South Africa—The Ministry of Labour and National Service, Appointments Department, Technical and Scientific Register, Room 572, York House, Kingsway, London, W.C.2, quoting F.130.B (January 31).

DEPUTY CITY ELECTRICAL ENGINEER—The City Electrical Engineer, 4 Duke Street, Norwich (February 8).

RESEARCH PHYSICIST on the staff of the DIVISION OF RADIOPHYSICS, Sydney, for advanced experimental work in connexion with the Division's programme of electron tube research and development—The Secretary, Australian Scientific Research Liaison Office, Australia House, Strand, London, W.C.2 (February 8).

SECRETARY-LIBRARIAN (woman) for the East African Agricultural Research Institute, Amani, Tanganyika (qualifications: B.Sc. degree and ability to read French, Dutch and German)—The Ministry of Labour and National Service, Appointments Department, Technical and Scientific Register, Room 572, York House, Kingsway, London, W.C.2, quoting F.131.B (February 9).

DISTILLERY EXPERT in the service of the Government of the U.P., India (must be highly qualified distillery technologist specializing in biochemistry of fermentation but with sufficient knowledge of chemical engineering to advise distillers on constructional and allied problems)—The Ministry of Labour and National Service, Appointments Department, Technical and Scientific Register, Room 572, York House, Kingsway, London, W.C.2, quoting F.3813.A (February 9).

CIVIL ENGINEERS (Ref. No. E.1911.A) and SANITARY ENGINEERS (Ref. No. E.2184.A) in Burma, DEPUTY DIRECTORS in the BURMA VETERINARY DEPARTMENT (Ref. No. F.5359.A), and ECONOMIC BOTANISTS in the Burma Agricultural Department (Ref. No. F.5358.A)—The Ministry of Labour and National Service, Appointments Department, Technical and Scientific Register, Room 572, York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (February 11).

CHAIR OF NATURAL PHILOSOPHY—The Secretary, The University, Aberdeen (February 15).

LECTURER IN INDUSTRIAL HEALTH—The Registrar, The University, Manchester 13 (February 16).

ENGINEERING ASSISTANT (temporary), and an ENGINEERING ASSISTANT (permanent), in the office of the Engineer and Surveyor—The Clerk to the Council, Council Offices, Esher, Surrey (February 22).

RURAL SCIENCE ORGANISER on the staff of the County Education Committee—The Chief Education Officer, County Hall, Taunton (February 23).

GENERAL MANAGER AND CHIEF ENGINEER to the London and Home Counties Joint Electricity Authority—Leslie Gordon, Clerk and Solicitor, 5–6 Lancaster Place, Strand, London, W.C.2 (February 28).

SENIOR BIOCHEMIST—The General Superintendent, Royal Sheffield Infirmary and Hospital, Sheffield (March 1).

REGIUS PROFESSOR OF ENGINEERING in the University of Edinburgh, REGIUS PROFESSOR OF CLINICAL SURGERY in the University of Edinburgh, and REGIUS PROFESSOR OF MIDWIFERY in the University of Glasgow—The Private Secretary, Scottish Office, Fielden House, 10 Great College Street, London, S.W.1 (March 4).

SENIOR LECTURER IN CHEMISTRY—The Registrar, The University, Sydney (by Air Mail, March 9).

SCIENTIFIC ASSISTANTS with a knowledge of foreign languages and training or experience in dairy science or in sciences which are fundamental to dairy science—The Director, Imperial Bureau of Dairy Science, Shinfield, Reading.

LECTURER IN PHYSIOLOGY—The Principal, South African Native College, Fort Hare, C.P., South Africa.

LECTURER (male) IN BOTANY at the University of the Witwatersrand, Johannesburg—The Secretary, Universities Bureau of the British Empire, c/o University College, Gower Street, London, W.C.1.

JUNIOR RESEARCH WORKER for experimental cancer laboratory—Dr. A. W. Greenwood, Institute of Animal Genetics, The University, West Mains Road, Edinburgh 9.

LABORATORY ASSISTANT FOR BOTANY DEPARTMENT—The Assistant Registrar, Queen Mary College, Mile End Road, London, E.1.

ASSISTANT DIVISIONAL ENGINEERS—The Chief Engineer, Thames Conservancy, De Bohun Road, Reading.

ASSISTANT LECTURER IN PHYSICS, and a LECTURER IN MINING, in the Huddersfield Technical College—The Director of Education, Education Offices, Peel House, Huddersfield.